2024-1065

United States Court of Appeals for the Federal Circuit

JOHN R. WILSON, WILSON WOLF MANUFACTURING CORP.,

Plaintiffs-Appellants,

v.

CORNING INCORPORATED,

Defendant-Appellee.

Appeal from the United States District Court for the District of Minnesota, in Case No. 0:13-cv-00210-DWF-TNL

BRIEF OF APPELLANTS

Devan V. Padmanabhan
Sri K. Sankaran
Paul J. Robbennolt
Michelle E. Dawson
Erin O. Dungan
Mariah L. Reynolds
Britta S. Loftus
Padmanabhan & Dawson, PLLC
9800 Shelard Parkway, Suite 120
Minneapolis, MN 55441
Telephone: (612) 444-3601

Attorneys for Plaintiffs-Appellants

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UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

CERTIFICATE OF INTEREST

Case Number 24-1065

Short Case Caption Wilson v. Corning Incorporated

Filing Party/Entity Wilson

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Provide the full names of all entities represented by undersigned counsel in this case.	Provide the full names of all real parties in interest for the entities. Do not list the real parties if they are the same as the entities. ☑ None/Not Applicable	Provide the full names of all parent corporations for the entities and all publicly held companies that own 10% or more stock in the entities. ☐ None/Not Applicable
John R. Wilson		Bio-Techne Corp.
Wilson Wolf Mfg. Corp		

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STATEMENT OF RELATED CASES

This is an appeal from the Findings of Fact, Conclusions of Law, and Order for Judgment of the United States District Court for the District of Minnesota ordering judgment in favor of Appellee Corning Incorporated ("Corning") and against Appellants John R. Wilson and Wilson Wolf Manufacturing Corp. (collectively, "Wilson Wolf") in case number 0:13-cv-210-DWF-TNL. No other appeal in or from the same civil action or proceeding was previously before this or any other appellate court.

There are no other cases known to counsel to be pending in this or another court or agency that may directly affect or be directly affected by this Court's decision in this appeal.

There is one other case between the parties to this case pending in the United States District Court for the District of Minnesota, captioned *Corning Incorporated v. Wilson Wolf Manufacturing Corporation and John R. Wilson*, No. 0:20-cv-00700-DWF-TNL, as well as three related cases pending in other district courts: *Wilson Wolf Manufacturing Corporation v. Brammer Bio, LLC*, No. 1:19-cv-02315-RGA (D. Del.); *Wilson Wolf Manufacturing Corporation v. Sarepta Therapeutics, Inc.*, No, 1:19-cv-02316-RGA (D. Del.); and *Wilson Wolf Manufacturing Corporation v. Nationwide Children's Hospital Inc., et al.*, No. 2:20-cv-00192-MHW-CMV (S.D. Ohio). These cases concern Wilson Wolf's

assertions that the use of Corning's HYPERStack cell culture device infringes three patents owned by Wilson Wolf: U.S. Patent Nos. 9,441,192 ("the '192 Patent"), 9,732,317 ("the '317 Patent"), and 8,697,443 ("the '443 Patent"). The '192, '317, and '443 Patents were not asserted or at issue in the present case, and Wilson Wolf believes that these additional cases will not directly affect or be directly affected by this Court's decision in this appeal.

JURISDICTIONAL STATEMENT

The district court had jurisdiction over Wilson Wolf's patent infringement and correction of inventorship claims pursuant to 28 U.S.C. §§ 1331 and 1338(a). The district court had diversity jurisdiction over Wilson Wolf's state law claims for breach of contract and misappropriation of trade secrets pursuant to 28 U.S.C. § 1332. The district court also had supplemental jurisdiction over Wilson Wolf's state law claims pursuant to 28 U.S.C. § 1367(a).

This Court has jurisdiction under 28 U.S.C. § 1295(a)(1), because this is an appeal from a final decision of a district court of the United States in a civil action arising under the Patent Act.

STATEMENT OF THE ISSUES

1. Whether the district court erred in denying Wilson Wolf a trial by jury on its contract and trade secret claims, even though Wilson Wolf sought compensatory damages in connection with both claims.

2. Whether the district court erred in allowing Corning to amend its Answer to assert a statute of limitations defense, where Corning did not plead a statute of limitations defense, where for ten years the district court had repeatedly denied Corning leave to amend, and where Wilson Wolf had reasonably relied on the district court's denial of leave to amend when it conducted discovery.

3. Whether the district court erred in holding that Wilson Wolf's disgorgement remedy was barred by laches, where laches is not available for breach of contract and trade secret claims, and where the remedy being sought was not equitable in nature.

STATEMENT OF THE CASE

This case should have been tried to a jury. It is undisputed that Wilson Wolf is entitled to a jury trial on its breach of contract and trade secret misappropriation claims so long as the relief being sought is legal, rather than equitable. And the damages sought by Wilson Wolf in this case unequivocally constitute a legal remedy. Specifically, Wilson Wolf's damages expert explicitly labeled one part of her analysis "compensatory" and there considered expectation damages, lost profits damages, and damages based on a reasonable royalty. Those are legal remedies. Wilson Wolf's damages expert then labeled an alternative part of her damages analysis "unjust enrichment" which, as this Court has explicitly recognized, can be compensatory (and hence a legal remedy) if designed not to punish, but instead to serve as a proxy for the harm caused. Wilson Wolf was thus entitled to a trial by jury, and the district court erred when it struck Wilson Wolf's jury demand.

Moreover, although Wilson Wolf is not entitled to have a jury determine its correction of patent inventorship claims, that inventorship dispute has underlying factual issues in common with disputes that are going to a jury, and the Seventh Amendment thus requires that the jury decide those common issues. Specifically, in support of its trade secret and contract claims, Wilson Wolf contends that

Corning misappropriated Wilson Wolf's confidential and trade secret information. And, in support of its inventorship claim, Wilson Wolf almost identically contends that Corning misused Wilson Wolf's confidential and trade secret information. Thus, the same evidence and allegations underlying Wilson Wolf's trade secret and breach of contract claims are central to Wilson Wolf's correction of inventorship claims. When the district court decided Wilson Wolf's inventorship claims without submitting the overlapping factual disputes to a jury, the district court impermissibly deprived Wilson Wolf of its Seventh Amendment right.

These same problems undermine the district court's determination of Corning's affirmative defenses. To the extent Corning was properly permitted to assert a statute of limitations defense, that defense must be submitted to the jury with Wilson Wolf's claims. And both the statute of limitations defense and Corning's laches defense must be heard by the jury, because common facts are at issue in those defenses and in Wilson Wolf's jury-triable claims.

Separately, even if there were no issue with respect to the right to trial by jury, the district court's determination of Corning's affirmative defenses would still be improper as a matter of law.

The district court abused its discretion in allowing Corning to assert a statute-of-limitations defense so late in the process. Corning ***did not*** assert a

statute-of-limitations defense in its original Answer. After missing all deadlines to amend its Answer, Corning unsuccessfully sought permission from the district court to amend on multiple occasions. In fact, the district court denied ***three*** such requests between 2013 and 2022 and left the issue undisturbed between 2013 and 2023. In that context, Wilson Wolf reasonably relied on the fact that the statute of limitations was not an issue in the case. Importantly, during fact discovery, Wilson Wolf did not develop facts related to fraudulent concealment, which is the natural legal response to Corning's statute-of-limitations argument. The district court's decision to permit Corning's amendment severely prejudiced Wilson Wolf, and therefore was an abuse of discretion. This Court should reverse that decision and vacate the implicated findings.

Finally, the doctrine of laches has no application to Wilson Wolf's claims in this case, and the district court's application of laches to Wilson Wolf's disgorgement remedy was legal error. Laches does not apply to claims that have an applicable statute of limitations established by statute, such as Wilson Wolf's trade secret and contract claims. Laches thus does not apply to the claims in this case. The district court held that laches barred Wilson Wolf's disgorgement remedy, presumably on the grounds that disgorgement was an equitable remedy. However, as explained above, Wilson Wolf's unjust enrichment remedy seeking

disgorgement of Corning's profits is a legal remedy, rather than an equitable remedy, because it is intended to compensate Wilson Wolf for the losses it has suffered as a result of Corning's actions. Accordingly, the district court's application of laches to Wilson Wolf's unjust enrichment remedy was legal error.

In short, the district court deprived Wilson Wolf of its Seventh Amendment right to a trial by jury, and also ruled incorrectly on two critical affirmative defenses. Accordingly, this Court should vacate the district court's Opinion, and remand this matter for a jury trial.

I. THE PARTIES

John Wilson is an entrepreneur and innovator in the design and development of "cell culturing" technologies. Cell culturing technologies facilitate the growth of large numbers of cells in the laboratory environment. Wilson started a company, Wilson Wolf, that today generates $70 million in annual revenue manufacturing and selling cell culture devices that he designed. Appx8106. Wilson Wolf's customers are private, public, non-profit and governmental researchers who are working on everything from cancer to diabetes. Appx8104-8105.

Corning is a multinational corporation headquartered in Corning, New York. One part of Corning's business involves the manufacture and sale of competing cell culture devices.

II. WILSON WOLF'S CLAIMS

Wilson Wolf invented new technologies for cell culture devices centered around the use of gas permeable membranes. Appx255-262. Among other advantages, Wilson Wolf's designs eliminated the need to maintain air pockets inside a cell culture device, and they also allowed for the stacking of multiple cell culture shelves. *Id.* As a result of these innovations, a scientist or doctor can grow at least ***ten times*** as many cells in the same space. *Id.*; Appx1113.

In late 2003, Corning asked to meet with Wilson Wolf to learn more about Wilson Wolf's cell culture technologies. Appx263 at ¶ 40. The parties executed a Confidential Disclosure Agreement ("CDA") in January 2004. Appx263-264 at ¶¶ 41-44. Pursuant to the CDA, Wilson Wolf disclosed confidential and trade secret information regarding its cell culture technologies to Corning. Appx264-270 at ¶¶ 45-79. Corning told John Wilson that if his device could grow cells that rapidly, he would "change the face of cell culture." Appx7893, Appx9235-9239, But Corning explained that its scientists were skeptical about Wilson's claimed performance because Wilson's designs ran contrary to Corning's understanding of cell culture biology. *Id.* Corning then tested Wilson's devices in Corning's lab, concluding in a written report that Wilson's devices actually delivered the breathtaking performance that he had promised. Appx1221-1222, Appx9238.

Unfortunately, instead of pursuing a business agreement with Wilson Wolf, Corning simply stole Wilson Wolf's confidential and trade secret information, in violation of the CDA, to design and develop its HYPERFlask and HYPERStack products. Much like Wilson Wolf's inventions, those products are cell culture devices that use gas permeable membranes, eliminate the air pockets inside the cell culture device, and incorporate a stack of multiple cell culture shelves. Appx273-274 at ¶¶ 99-101. Corning also secretly filed patent applications claiming Wilson Wolf's technology as Corning's own. Appx270-273 at ¶¶ 80-98. These applications resulted in three U.S. patents issued to Corning. Appx273 at ¶¶ 97-98.

On January 25, 2013, Wilson Wolf filed this action against Corning. Wilson Wolf alleged that Corning breached the non-disclosure agreement when it used Wilson Wolf's confidential information [a] to develop the HYPERFlask and HYPERStack products, and [b] to file its own patent applications. Appx278-280 at ¶¶ 125-135. Wilson Wolf also asserted a claim for trade secret misappropriation under the Minnesota Uniform Trade Secrets Act (MUTSA), 325C.01 *et seq.* Appx280-284 at ¶¶ 141-163. And Wilson Wolf brought claims seeking correction of inventorship on the three Corning Patents. Appx274-278 at ¶¶ 102-124.[1]

[1] Wilson also brought a patent infringement claim, asserting that the HYPERFlask and HYPERStack infringed two Wilson Wolf patents. Appx284-285. The asserted

III. WILSON WOLF'S DAMAGES

Wilson Wolf's damages expert, Carol A. Ludington, filed an expert report offering opinions on the damages that Wilson Wolf suffered as a result of Corning's breach of the non-disclosure agreement and its misappropriation of Wilson Wolf's trade secrets. Appx6426-6506. Ludington's analysis was the same under both causes of action. She offered opinions on two different, alternative measures of damages. First, Ludington opined that Wilson Wolf was entitled to compensatory damages, which could be quantified as expectation damages, lost profits, or a reasonable royalty. Appx6431-6432, Appx6484. As part of this analysis, Ludington performed a reasonable royalty analysis to determine the reasonable royalty that Wilson Wolf was entitled to as compensation for Corning's misappropriation of trade secrets, as well as the expectation or reliance damages suffered by Wilson Wolf due to Corning's breach of contract. Appx6495-6501.

Second, and in the alternative, Ludington opined that Wilson Wolf was entitled to unjust enrichment damages based on the profit Corning earned through

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claims of those patents were method claims; Corning performed one step of the claims, and its customers performed all of the other steps. Wilson Wolf was forced to voluntarily dismiss its infringement claim after this Court's decision in *Akamai Techs., Inc. v. Limelight Networks, Inc.*, 797 F.3d 1020 (Fed. Cir. 2015). Appx803-804, 881. Wilson Wolf also asserted a claim for unjust enrichment and constructive trust; the district court dismissed that claim on summary judgment. Appx3340.

the unauthorized use of Wilson Wolf's confidential information and trade secrets. Appx6470-6484 at ¶¶ 106-144. These unjust enrichment damages were not punitive in nature, but rather were meant to compensate Wilson Wolf for the loss it had suffered as a result of Corning's actions. Ludington detailed the adverse impacts suffered by Wilson Wolf in addition to the lack of compensation paid by Corning. Appx6499-6501. The unjust enrichment damages calculated by Ludington were calibrated to compensate Wilson Wolf for these adverse impacts.

A. Wilson Wolf's Request for Compensatory Damages in the Form of a Reasonable Royalty Analysis

As noted, Ludington calculated Wilson Wolf's compensatory damages, quantified as expectation damages, lost profits, and a reasonable royalty. Appx6431-6432, Appx6484 ("Compensatory damages may be based on various damages measures, including lost profits, expectation damages and reasonable royalties.") Ludington's analysis of the compensatory damages that Wilson Wolf suffered as a result of Corning's actions was based on extensive evidence and analysis. *See*, *generally*, Appx6484-6501 at ¶¶ 146-217. As part of her analysis, Ludington conducted a reasonable royalty analysis. Appx6495-6501. As Ludington explained, had Corning not misappropriated and improperly used Wilson Wolf's confidential information and trade secrets, Wilson Wolf and Corning would have entered into a business arrangement that would have paid Wilson Wolf for

Corning's use of its technology. Ludington thus attempted to construct the hypothetical agreements the parties would have made had Corning not engaged in bad acts. Appx6485 at ¶ 147. She described these potential agreements and thoroughly discussed them. Appx6485-6487 at ¶¶ 148-158.

In order to evaluate the outcome of the parties' hypothetical negotiation, Ludington relied on substantial relevant evidence. **First**, she considered agreements that Corning had negotiated with other inventive companies to bring similarly innovative technologies to market. Appx6487-6491 at ¶¶ 159-173. **Second**, she considered Corning's internal statements regarding the negotiation of potential agreements **with Wilson Wolf** regarding the technology at issue. Appx6491-6493 at ¶¶ 174-180. **Third**, she considered Wilson Wolf's agreements with other larger partners to commercialize technologies in similar circumstances. Appx6497-6498 at ¶¶ 199-201. **Fourth**, she analyzed the agreement Wilson Wolf actually proposed to Corning. Appx6493-6499 at ¶¶ 181-208. Based on this analysis, Ludington concluded that an example of an agreement that parties may have reached through a hypothetical negotiation would be an OEM arrangement under which Wilson Wolf would manufacture the product, and Corning would distribute it. Appx6498-6499 at ¶¶ 205-208. Wilson Wolf would receive a "raw cost" to manufacture the product, calculated to be 65% of the retail price. *Id.* The

manufacturing costs were estimated to be about 30% of the retail price, leaving Wilson Wolf with about 35% of the retail price as profit. *Id.* Corning, for its part, would retain the markup from 65% to the full retail price, which would also equal about 35% of the retail price. *Id.* This calculation provides an estimate of Wilson Wolf's lost profits (35%), and it is therefore a measure of the compensatory damages that Wilson Wolf suffered as a result of Corning's actions.

Ludington's analysis is analogous to a reasonable royalty analysis like that used frequently to determine damages in patent infringement cases. In fact, Ludington specifically analyzed the *Georgia-Pacific* reasonable royalty factors. Appx6495-6501.

B. Wilson Wolf's Unjust Enrichment Analysis is Simply Another Way of Measuring Compensatory Damages

In order to compensate Wilson Wolf for Corning's misconduct, Ludington also looked to Corning's unjust enrichment as a measure of the harm done to Wilson Wolf. Ludington calculated Wilson Wolf's unjust enrichment damages using revenue from Corning's sales of the HYPER platform products, reduced by standard manufacturing costs, and further reduced by incremental non-manufacturing costs, in order to obtain incremental profits. *See* Appx6436 at ¶ 22. These damages are a good proxy for the harm Wilson Wolf suffered as a result of Corning's bad acts. Appx6499-6501 at 74-76. That is, while the math focused on

Corning's revenue and costs, these numbers were an estimate of the compensation that would make Wilson Wolf whole.

C. Both Reasonable Royalty and Unjust Enrichment Damages Are Available as Compensatory Damages for Both Breach of Contract and Trade Secret Misappropriation

The MUTSA explicitly allows damages to be calculated by reference to a reasonable royalty and/or by reference to unjust enrichment. "Damages can include both the actual loss caused by misappropriation and the unjust enrichment caused by misappropriation that is not taken into account in computing actual loss." Minn. Stat. § 325C.03(a). The statute explicitly allows a reasonable royalty analysis such as that conducted by Ludington: "In lieu of damages measured by any other methods, the damages caused by misappropriation may be measured by imposition of liability for a reasonable royalty for a misappropriator's unauthorized disclosure or use of a trade secret." *Id.*

Both measures of damages are also available for breach of contract. That is, damages in cases involving breach of confidentiality agreements may be measured not only by the amount of the plaintiff's loss, but also by the amount of the defendant's gain resulting from the breach. *Cherne Indus., Inc. v. Grounds & Assocs., Inc.*, 278 N.W.2d 81, 94 (Minn. 1979); *Storage Tech. Corp. v. Cisco Systs., Inc.*, 395 F.3d 921, 925 (8th Cir. 2005); *Ahle v. Veracity Research Co.,* 641

F. Supp. 2d 857, 861 (D. Minn. 2009). For example, "where an employee wrongfully profits from the use of information obtained from his employer, the measure of damages may be the employee's gain." *Cherne*, 278 N.W.2d at 94, *citing* Dobbs, Remedies § 10.5, at 693. "Also, [the Minnesota Supreme Court] has specifically found that the violator of a covenant not to compete may be required to account for his profits, and such illegal profits may properly measure the damages." *Id.* at 94-95, *citing Peterson v. Johnson Nut Co.*, 297 N.W. 178, 182 (Minn. 1941).

IV. WILSON WOLF'S CORRECTION OF INVENTORSHIP CLAIMS

The same facts that give rise to Wilson Wolf's claims for breach of contract and trade secret misappropriation also give rise to Wilson Wolf's claims for correction of inventorship. Those facts: Wilson Wolf contends that it disclosed information regarding its cell culture technology in confidence to Corning, and that Corning included this confidential information in Corning's patent applications. The same factual contentions thus underlie both the inventorship claim and the breach of contract claim. For both, Wilson Wolf alleges that Corning made unauthorized use of trade secret and confidential information that was provided to Corning by Wilson Wolf under contract.

V. CORNING DID NOT PLEAD A STATUTE OF LIMITATIONS DEFENSE IN ITS ANSWER, AND THE DISTRICT COURT REPEATEDLY DENIED CORNING LEAVE TO AMEND

Corning did not plead a statute of limitations defense in its Answer in March 2013. *See* Appx536-551. Nor did Corning move for leave to amend its Answer prior to September 1, 2013, the court-ordered deadline for such motions. Appx553, Appx563. In fact, Corning first moved to amend its Answer to plead a statute of limitations defense in November 2013, long after the deadline for such motions had passed. Appx565-566. The magistrate judge denied Corning's motion, holding that Corning had not demonstrated good cause because Corning had not been diligent in seeking to amend its Answer. Appx642-643 (holding that "the relevant information necessary to bring a statute of limitations argument was available to Defendant well before this Court's amended pleadings deadline of September 1, 2013"). When Corning objected to the magistrate judge's denial of leave to amend, the district court affirmed the magistrate judge's order. Appx800-802. As a result, at all times from the filing of the Complaint through the completion of fact discovery, the statute of limitations was not an issue in the case. Wilson Wolf reasonably relied on these rulings when taking discovery in this matter. Because Corning was not permitted to plead a statute of limitations defense, Wilson Wolf

did not develop a factual record that would permit it to respond. The statute of limitations was simply not part of the fight.

Nevertheless, in July 2020, ***six years*** after the close of discovery, Corning again asked the Court for leave to amend its answer to plead a statute of limitations defense. Appx5158-5159. The district court promptly ruled that there was "no basis for" Corning's requested motion, and therefore denied Corning's request. Appx170 at Dkt. 615 (text only). By the time Corning yet again asked for permission to assert a statute of limitations defense on the eve of trial, *see* Appx7421-7424, Wilson Wolf had relied on the district court's denial of that request for almost ***ten years***. The district court again denied Corning's request, although it reserved the right to "address any statute of limitations issues or evidentiary matters that arise as a matter of law based on the evidence presented at trial by motion to the Court." Appx7432.

Thus, throughout discovery, the statute of limitations was not part of the case. Moreover, going into trial, the statute of limitations was still not part of the case. And, at trial, Wilson Wolf was under extreme pressure to meticulously honor that exclusion. Why? Because Corning had stated its intention to move **after trial** to amend its Answer to allege a statute of limitations defense pursuant to Rule 15(b)(2), governing "issues tried **by consent**," Appx7424 (threatening to move to

amend "to conform the pleadings to the evidence," the language of Rule 15(b)(2) governing "Issues Tried by Consent"). Wilson Wolf thus very carefully avoided arguing about fraudulent concealment (the response it would have developed had the statute of limitations been timely raised) so as not to accidentally open that door.

VI. RELEVANT PROCEDURAL HISTORY

In February 2022, Corning moved to strike Wilson Wolf's jury demand on all remaining claims. Appx5163-5165. The district court granted Corning's motion and struck Wilson Wolf's jury demand. Appx96-105. In its analysis of Wilson Wolf's claims, the district court concluded that all of Wilson Wolf's damages measures were based on disgorgement of Corning's profits. Appx99-103. The district court held that the remedy of disgorgement of profits is always equitable in nature, and therefore concluded that Wilson Wolf was not entitled to a jury trial on any of its claims. *Id.*

The remaining claims proceeded to a bench trial beginning on November 7, 2022. Appx7530. After a three-week trial and post-trial briefing, the district court issued its Opinion, finding in favor of Corning on all issues. Appx2-95. The district court permitted Corning to amend its Answer to plead a statute of limitations defense, Appx2-5, then held that Wilson Wolf's trade secret and contract claims

were both time-barred. Appx84-85, Appx87-88. The district court also held that Wilson Wolf's disgorgement remedy was barred by the doctrine of laches. Appx88-91.

SUMMARY OF THE ARGUMENT

Wilson Wolf is entitled to a trial by jury on its contract and trade secret claims. There can be no dispute that these causes of action give rise to the right to a jury trial so long as Wilson Wolf seeks at least one legal remedy. And Wilson's request for compensatory damages, including damages based on Ludington's reasonable royalty analysis, is a legal remedy. Although Wilson Wolf believes that the district court made other errors, too, this Court can fully resolve Wilson Wolf's appeal by focusing on just this one issue. The fact that Wilson Wolf was denied its requested jury trial mandates that the district court's Opinion be fully vacated, as every issue resolved therein is either [a] a claim that should have been decided by a jury (such as breach of contract, trade secret misappropriation, or the statute of limitations), or [b] an issue that rests on factual findings in common with those jury claims (such as patent inventorship and the laches defense), meaning that those issues should only be decided after the jury resolves the common factual issues.

Moreover, even if Wilson Wolf had not been entitled to a jury trial based on its request for compensatory damages as measured by Ludington's reasonable royalty analysis, Wilson Wolf would still have been entitled to a jury trial based on its request for compensatory damages as measured by Ludington's unjust enrichment analysis. While unjust enrichment is not ***always*** a legal remedy, it is a

legal remedy when it is used, as here, for the purpose of estimating compensatory damages. Phrased differently, even though unjust enrichment math focuses on the defendant's revenue and the defendant's costs, it is a compensatory measure in instances where those calculations are designed to estimate the harm suffered by the plaintiff. Consistent with this principle, **every** district court that has considered requests for unjust enrichment damages under the Uniform Trade Secrets Act has concluded that unjust enrichment damages are a legal remedy, and that the plaintiff therefore enjoys a right to a trial by jury. *See Ford Motor Co. v. Intermotive, Inc.*, No. 4:17-cv-11584-TGB-APP, 2023 WL 6850576, at *4-6 (E.D. Mich. Oct. 17, 2023); *Medidata Sols., Inc. v. Veeva Systs., Inc.*, No. 17-civ-589 (LGS), 2022 WL 585726, at *1-2 (S.D. N.Y. Feb. 25, 2022); *MSC Software Corp. v. Altair Eng'g, Inc.*, No. 07-12807, 2016 WL 1714873, at *2 (E.D. Mich. Jan. 7, 2016); *De Lage Landen Operational Services, LLC v. Third Pillar Systems, LLC*, No. 09–2439, 2011 WL 1627899 (E.D. Pa. Apr. 28, 2011); *Newark Group, Inc. v. Sauter*, No. C2:01-cv-1247, 2004 WL 5782100 (S.D. Ohio 2004); *Control Ctr. L.L.C. v. Lauer*, 288 B.R. 269 (M.D. Fla.2002). For this reason, too, Wilson Wolf's contract claims and trade secret claims should have gone to a jury, and that same jury should have been allowed to decide the facts in common between those claims and the patent ownership claim, the statute of limitations defense, and the laches defense.

Finally, separate from the issues related to the right to a jury trial, the district court abused its discretion by allowing Corning to assert a statute of limitations defense so late in the process; and the district court erred by considering an equitable defense (laches) in relation to a legal claim (compensatory damages as measured by unjust enrichment) because legal claims are not subject to equitable defenses.

Accordingly, this Court should vacate the district court's Opinion, and remand this matter for a jury trial.

ARGUMENT

I. THIS COURT SHOULD VACATE THE DISTRICT COURT'S OPINION IN ITS ENTIRETY BECAUSE WILSON IS ENTITLED TO A TRIAL BY JURY

A. Standard of Review: De Novo

"The constitutional question of whether a party is entitled to a jury trial is a question of law that this court reviews de novo." *DePuy Spine, Inc. v. Medtronic Sofamor Danek, Inc.*, 567 F.3d 1314, 1322-23 (Fed. Cir. 2009), *quoting Tegal Corp. v. Tokyo Electron Am., Inc.*, 257 F.3d 1331, 1339 (Fed. Cir. 2001).

B. The Relevant Legal Standards

1. The Seventh Amendment Right to Trial by Jury

The Seventh Amendment provides that, "[i]n Suits at common law, where the value in controversy shall exceed twenty dollars, the right of a trial by jury

shall be preserved ….” “Suits at common law” “refers to ‘suits in which legal rights [are] to be ascertained and determined, in contradistinction to those where equitable rights alone [are] recognized, and equitable remedies [are] administered.’” *Chauffeurs, Teamsters & Helpers, Loc. No. 391 v. Terry*, 494 U.S. 558, 564 (1990), *quoting Parsons v. Bedford*, 3 Pet. 433, 447, 7 L.Ed. 732 (1830). To determine whether an action resolves legal rights, the Court must “examine both the nature of the issues involved and the remedy sought.” *Id.* “First, we compare the statutory action to 18th-century actions brought in the courts of England prior to the merger of the courts of law and equity. Second, we examine the remedy sought and determine whether it is legal or equitable in nature.” *Tull v. United States*, 481 U.S. 412, 417-418 (1987).

“Maintenance of the jury as a fact-finding body is of such importance and occupies so firm a place in our history and jurisprudence that any seeming curtailment of the right to a jury trial should be scrutinized with the utmost care.” *Beacon Theaters, Inc. v. Westover*, 359 U.S. 500, 501 (1959), *quoting Dimick v. Schiedt*, 293 U.S. 474, 486 (1935). “When legal and equitable claims are joined in the same action, the right to jury trial on the legal claim, **including all issues common to both claims**, remains intact.” *Lytle v. Household Mfg., Inc.*, 494 U.S. 545, 550 (1990) (emphasis added). “In such a case, the jury must first resolve any

common issues of fact; the district court then can resolve those claims that are for it to determine." *Material Supply Int'l, Inc. v. Sunmatch Indus. Co.*, 146 F.3d 983, 988 (D.C. Cir. 1998), *citing Lytle*, 494 U.S. at 556 n. 4; and *Dairy Queen, Inc. v. Wood*, 369 U.S. 469, 472–73 (1962).

2. Breach of Contract and Misappropriation of Trade Secrets are Unequivocally Jury Claims

There can be no dispute regarding the first part of the Supreme Court's two-part test to determine the right to a trial by jury: Wilson Wolf's breach of contract and trade secret misappropriation claims are both traditional legal claims, rather than equitable claims. "[T]he Seventh Amendment preserves a right to a jury trial on issues of fact in suits for breach of contract damages between private party litigants." *Seaboard Lumber Co. v. U.S.*, 903 F.2d 1560, 1563 (Fed. Cir. 1990), *citing Northern Pipeline Constr. Co. v. Marathon Pipe Line*, 458 U.S. 50 (1982), *superseded by statute on other grounds as stated in Wellness Int'l Network, Ltd. v. Sharif*, ___ U.S. ___, 135 S.Ct. 1932. *See also* Appx102 (district court here recognizing that contract claims have historically been tried by jury). Trade secret claims also give rise to the right to a jury trial. *Texas Adv. Optoelectronic Sols., Inc. v. Renesas Elecs. Am., Inc.*, 895 F.3d 1304, 1318 (Fed. Cir. 2018) ("*TAOS*") (liability for trade secret misappropriation properly tried to a jury). Accordingly,

the only issue for this Court to determine is whether any of the remedies sought by Wilson Wolf are legal remedies.

C. Wilson Wolf's Request for Reasonable Royalties is a Request for Compensatory Damages, and is therefore a Legal Remedy For Which Wilson Wolf is Entitled to a Jury Trial

1. Wilson Wolf's Reasonable Royalty-Based Damages are a Legal Remedy

As explained in detail above, damages expert Ludington analyzed compensatory damages that estimate Wilson Wolf's actual loss as a result of Corning's unauthorized use of Wilson Wolf's confidential information and trade secrets, including expectation damages, lost profits, and a reasonable royalty. Appx6484. For her reasonable royalty analysis, Ludington worked to define the agreement that Corning and Wilson Wolf would have reached in a hypothetical negotiation regarding compensation for Wilson Wolf. This reasonable royalty represents the amount of money that Wilson Wolf lost when Corning took Wilson Wolf's property without such an agreement—compensatory damages for Wilson Wolf.[2]

[2] While the district court refers to Ludington's reasonable royalty analysis as disgorgement of profits, Appx100-101, that labeling is simply incorrect. According to Ludington's analysis, Corning's gross profits on these devices are on the order of 40 percent. Appx6503. Ludington's reasonable royalty analysis, based on Corning's comparable contracts, Wilson Wolf's comparable contracts, the parties'

Compensatory damages are a traditional form of legal relief. *Chauffeurs*, 494 U.S. at 570. They are a quintessential legal remedy that entitles the claimant to a trial by jury. *See*, *e.g.*, *Ross v. Bernhard*, 396 U.S. 531, 542 (1970) ("we have no doubt that the corporation's claim is, at least in part, a legal one. The relief sought is money damages."); *Dairy Queen*, 369 U.S. at 476 ("insofar as the complaint requests a money judgment it presents a claim which is unquestionably legal").

The fact that Ludington calculated compensatory damages in the form of a reasonable royalty does not change this conclusion. Reasonable royalty damages are a legal remedy that entitles the claimant to a jury trial. *See*, *e.g.*, *Minks v. Polaris Indus., Inc.*, 546 F.3d 1364, 1370-1375 (Fed. Cir. 2008) (vacating district court's reduction of "compensatory reasonable royalty damages" without offer of new trial as a violation of plaintiff's Seventh Amendment right to trial by jury); *TAOS*, 895 F.3d at 1320 (referring to "the undisputedly legal remedy of a reasonable royalty"). The fact that the analysis focused on "Corning's actual and projected revenues and/or profits on its HYPERFlask and HYPERStack products"

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internal discussions regarding potential agreements, and Wilson Wolf's proposal to Corning, concluded that a willing Corning would have paid, directly or indirectly, roughly 20 percent to Wilson Wolf. *Id.* If Ludington's analysis had been a disgorgement analysis, she would have asked for 40 percent; there would have been no reason to allow Corning to keep any of the wrongful profits.

is not problematic. Appx99-100. In fact, reasonable royalty calculations are always based on the bad actor's sales; that is the base to which the reasonable royalty is applied. *Lucent Techs., Inc. v. Gateway, Inc.*, 580 F.3d 1301, 1338-1339 (Fed. Cir. 2009). And reasonable royalties are designed to compensate a plaintiff for the loss that was suffered as a result of the defendant's infringement or misappropriation. Thus, claims that seek a reasonable royalty are claims that seek a legal remedy and give rise to a Seventh Amendment right to a jury trial.

This analysis is conclusive and mandates that the district court's Opinion be vacated. To be clear, if Wilson Wolf is entitled to a jury trial on even one aspect of one of its claims, the district court's determination of all of Wilson's claims must be vacated. After all, the factual allegations and evidence underlying all of Wilson's claims are substantially the same: Corning misappropriated Wilson Wolf's trade secrets, which were also Wilson Wolf confidential information protected by the non-disclosure agreement, and improperly used that trade secret and confidential information. It is black-letter law that, when common factual allegations and evidence underlie jury-triable and court-triable claims, the jury-triable claims must be tried and determined by the jury before the court decides any court-triable issues.

Wilson Wolf plainly and unequivocally sought a reasonable royalty; a reasonable royalty is undisputedly a legal remedy; and Wilson Wolf was therefore entitled to a jury trial. The district court's order striking Wilson Wolf's jury demand deprived Wilson Wolf of that fundamental constitutional right.

2. The District Court's *in Limine* Order Does Not Bar Wilson Wolf's Compensatory Damages Claim Based on Reasonable Royalties

After it struck Wilson Wolf's jury demand, and before trial, the district court granted Corning's motion *in limine* "to exclude references to hypothetical contracts." Appx114. For the reasons explained below, this ruling did not bar Wilson Wolf's compensatory damages claim. Therefore, as explained above, this Court must vacate the district court's Opinion and remand this case for a jury trial.

The district court's *in limine* order excluding references to hypothetical contracts did not bar Wilson Wolf's reasonable royalty damages analysis. In her reasonable royalty analysis, Ludington considered many sources of evidence, including actual comparable agreements Corning had entered into with other parties, actual comparable agreements Wilson Wolf had entered into with other parties, Corning's internal statements regarding potential agreements with Wilson Wolf, and Wilson Wolf's actual proposal to Corning. Appx6487-6499 at ¶¶ 159-208. None of these materials considered by Ludington are "hypothetical contracts" that are the subject of the district court's *in limine* order. In fact, Ludington's

reasonable royalty analysis is based on very real contracts, including contracts between Wilson Wolf and other large manufacturing and distribution partners, and contracts between Corning and other small innovators. *Id.* Moreover, as noted, Ludington performed a traditional *Georgia-Pacific* reasonable royalty analysis, which included her analysis of the actual contracts described above, industry practices, the nature of the confidential information at issue, Corning's commercial embodiments and the benefits derived from their use, the profitability and success of Corning's commercial embodiments, the sale of products sold in conjunction with Corning's commercial embodiments, the length of time Corning used Wilson's confidential information, and the relationship between Corning and Wilson Wolf. Appx6495-6501. None of these factors constitute "hypothetical contracts" that are the subject of the district court's *in limine* order, and therefore that *in limine* order would not bar Ludington's compensatory damages and reasonable royalty analysis.[3]

To the extent that the district court's *in limine* order can be interpreted to bar Wilson Wolf's compensatory damages analysis, however, that order was erroneous

[3] Ludington's conclusions regarding Wilson Wolf's reasonable royalty damages did not require the jury (or district court) to apply the terms of any hypothetical contract, nor did her conclusions depend on any particular form of hypothetical contract. Appx6501.

and should be vacated by this Court. This Court applies regional circuit law to evidentiary determinations. *TecSec, Inc. v. Adobe Inc.*, 978 F.3d 1278, 1285 (Fed. Cir. 2020). Under Eighth Circuit law, the exclusion of evidence is reviewed for abuse of discretion. *Walker v. Kane*, 885 F.3d 535, 538 (8th Cir. 2018). Here, the district court provided no rationale or explanation for its order excluding references to hypothetical contracts: the entirety of the district court's order on this point reads, "Corning's Motion *in Limine* #13 (to exclude references to hypothetical contracts) (Doc. No. [739]) is **GRANTED**." Appx114. This Court should vacate the district court's evidentiary ruling on that basis alone; the district court failed to provide any rationale for its decision, rendering meaningful review by this Court impossible.[4]

[4] It is worth noting that Corning moved to exclude Ludington's unjust enrichment and compensatory damages analysis and testimony in 2017. The district court clearly understood the basis for Ludington's compensatory damages analysis back then, noting that, "[w]ith respect to compensatory damages, Ludington analyzed damages associated with Corning's use of Confidential Information without entering into a follow-up agreement that would have compensated Plaintiffs for the benefits that Corning derived from their use of Plaintiffs' Confidential Information." Appx4995. The district court denied Corning's *Daubert* motion and held that Ludington would be permitted to present all of her analysis to the jury. Appx4996-4997 ("the jury will be able to arrive at a damages figure using Ludington's various calculations and alternative ranges of damages … Corning will be free to challenge Ludington's calculations and the basis for them on cross-examination").

To the extent the district court intended to bar Wilson Wolf's compensatory damages claim on this motion *in limine*, however, that ruling was a clear abuse of discretion. The Minnesota Uniform Trade Secrets Act explicitly provides that "the damages caused by misappropriation may be measured by imposition of liability for a reasonable royalty …." Minn. Stat. § 325C.03. It is well-settled that reasonable royalty damages may be determined by analyzing a hypothetical negotiation between the parties. *MacDermid Printing Sols. LLC v. Cortron Corp.*, 833 F.3d 172, 191 n.84 (2nd Cir. 2016) (an "award based on a 'hypothetical negotiation,' also known as a 'reasonable royalty,' is common 'in both trade secret and patent cases'"), *quoting Vermont Microsystems, Inc. v. Autodesk, Inc.*, 138 F.3d 449, 450 (2nd Cir. 1998); *MGE UPS Systs., Inc. v. GE Consumer and Indus., Inc.*, 622 F.3d 361, 367 n.2 (5th Cir. 2010) ("Typically, to demonstrate reasonable royalty damages, a plaintiff presents evidence as to 'what the parties would have agreed to as a fair price for licensing the defendant to put the trade secret to the use the defendant intended at the time the misappropriation took place.'"), *quoting Univ. Computing Co. v. Lykes-Youngstown Corp.*, 504 F.2d 518, 539 (5th Cir. 1974). The centerpiece of the long-accepted *Georgia-Pacific* reasonable royalty analysis applied by Ludington in this case is the determination of a royalty based on the hypothetical negotiations between the plaintiff and the defendant. *Rite-Hite*

Corp. v. Kelley Co., Inc., 56 F.3d 1538, 1554-1555 (Fed. Cir. 1995). Barring a plaintiff seeking a reasonable royalty from analyzing the parties' hypothetical negotiation is a clear abuse of discretion.

D. Wilson Wolf's Request for Unjust Enrichment as an Alternative Measure of Its Compensatory Damages is Another Legal Remedy For Which Wilson Wolf is Entitled to a Jury Trial

The district court also erred in denying Wilson Wolf a jury trial on Wilson Wolf's unjust enrichment damages. When unjust enrichment damages are intended to compensate a plaintiff for his or her actual loss, such damages constitute a legal remedy, and the claimant is entitled to a jury trial. That is precisely the case here.

1. Unjust Enrichment Damages Constitute a Legal Remedy When They Are Intended to Compensate the Plaintiff for His Loss

Unjust enrichment damages may be either legal or equitable in nature. *Hughes v. Priderock Capital Partners, LLC*, 812 Fed. Appx. 828, 834 (11th Cir. 2020), *citing Great-West Life & Annuity Ins. Co. v. Knudson*, 534 U.S. 204, 212 (2002). The relevant question is whether the relief sought "seeks to punish the wrongdoer by taking his ill-gotten gains, thus, removing his incentive to perform the wrongful act again"–in which case it is equitable–or whether it "focus[es] on the plaintiff's losses and seek[s] to recover in money the value of the harm done to him." *Kerr v. Charles F. Vatterott & Co.*, 184 F.3d 938, 944 (8th Cir. 1999), *citing* Dan B. Dobbs, Law of Remedies § 4.1(1), at 369–71 (Abr.2d ed. 1993).

In this case, Wilson Wolf seeks unjust enrichment damages as a form of compensation for its actual losses as a result of Corning's unauthorized use and misappropriation of Wilson Wolf's confidential information and trade secrets. Therefore, in this case, the damages calculated by expert Ludington—whether they are called "unjust enrichment," restitution, or "disgorgement"—constitute a legal remedy, for which Wilson Wolf is entitled to a jury trial. In fact, in *TCL Comm. Tech. Holdings Ltd. v. Telefonaktiebolaget LM Ericsson*, this Court held that a jury trial was required where, as here, the plaintiff sought payment for defendant's past unauthorized sales and measured the appropriate payment by calculating the defendant's ill-gotten gains. 943 F.3d 1360, 1371- 74 (Fed. Cir. 2019). *See also Hughes*, 812 Fed. Appx. at 828 (unjust enrichment damages are legal remedy where plaintiff sought as damages for breach of implied contract "the value of the benefit [defendant] received from [plaintiff's] services"); *AcryliCon USA, LLC v. Lilikal GmbH*, 985 F.3d 1350, 1374 (11th Cir. 2021) ("The Seventh Amendment applies here because breach of contract is a traditional action at law, and a money judgment, even if based on restitution, is generally a legal remedy.").

2. Unjust Enrichment Damages Under the MUTSA are a Legal Remedy

This analysis regarding unjust enrichment damages is confirmed by other courts' treatment of similar claims for unjust enrichment damages under statutes

based on the Uniform Trade Secrets Act. Although the Courts of Appeals have not yet addressed this issue, district courts interpreting the Uniform Trade Secrets Act have uniformly held that "unjust enrichment" damages, like those sought by Wilson Wolf here, are a legal remedy that entitles the claimant to a jury trial.

For example, in *Newark Group, Inc. v. Sauter*, a court in the Southern District of Ohio considered a defendant's motion to strike the plaintiff's demand for a jury trial on its Ohio Trade Secrets Misappropriation Act claim because the plaintiff in that case sought money damages solely on an unjust enrichment theory. 2004 WL 5782100, at *1. The Ohio Trade Secrets Misappropriation Act, like the MUTSA, is modeled on the Uniform Trade Secrets Act. *See id.* at *1. Reviewing the damages section of the Ohio Uniform Trade Secrets Act–which is identical to the damages section of the MUTSA quoted above–the court found that seeking unjust enrichment damages under the trade secrets statute did not make a trade secret claim equitable. Rather, the court found that "unjust enrichment is the *method* by which [plaintiff's] monetary damages may be calculated under [the Ohio UTSA]," and noted that the damages section of the statute "acknowledges that calculating monetary damages for trade secret misappropriation may be difficult to ascertain, [and] it therefore provides specific methods by which to calculate monetary damages." *Id*. The court therefore held that "under the Seventh

Amendment, [plaintiff] is entitled to have its legal claim for monetary damages heard by a jury." *Id*. at *1-2.

Courts in other jurisdictions agree: actions seeking damages under state trade secret law modeled after the Uniform Trade Secrets Act are legal in nature regardless of the method used to calculate damages. *See Ford Motor Co.*, 2023 WL 6850576, at *4-6 (allowing unjust enrichment damages under Michigan UTSA to be tried to jury); *MSC Software*, 2016 WL 1714873, at *2 (holding that a claim for misappropriation of trade secrets under the Michigan UTSA is a "tort action at law" and that the plaintiff is "entitled to a jury trial on all aspects of the claim, including damages under an unjust enrichment theory."); *Medidata*, 2022 WL 585726, at *1-2 (allowing unjust enrichment damages under equivalent damages provision of the federal Defend Trade Secrets Act to be tried to jury); *De Lage Landen*, 2011 WL 1627899, at *3 (holding that plaintiff's claim for damages under a reasonable royalty theory under California's Uniform Trade Secrets Act must be submitted to the jury); *Control Ctr.*, 288 B.R. at 277-278 (holding that the plaintiff had a Seventh Amendment right to trial by jury on damages under the Florida Uniform Trade Secrets Act).

Contrary to the district court's analysis, this Court's decision in *TAOS* is inapposite. 895 F.3d at 1312 and n.2 (Fed. Cir. 2018). In *TAOS*, this Court held

that a trade secret claim seeking disgorgement of the defendant's profits was equitable, not legal. That case did not, however, consider a claim under the Uniform Trade Secrets Act. The case was decided under Texas common law, rather than the Texas Uniform Trade Secrets Act (TUTSA), because the cause of action accrued before the TUTSA took effect. Moreover, *TAOS* recognized that disgorgement claims can be legal in nature if they seek to compensate the plaintiff for his or her loss, which is our situation. "In some cases, a plaintiff seeking disgorgement as a remedy for trade secret misappropriation might prove that this measure of relief, though focused on the defendant's gains, is good evidence of damages in the form of the plaintiff's losses or of a reasonable royalty for use of the secret." *TAOS*, 895 F.3d at 1320 (emphasis added). "To be sure, monetary relief in the form of disgorgement, like other monetary relief, has been labeled a form of 'compensation' where awarded to a wronged plaintiff for an injury." *TAOS*, 895 F.3d at 1321, *citing Kokesh v. S.E.C.*, ––– U.S. ––––, 137 S. Ct. 1635, 1644, 198 L. Ed. 2d 86 (2017). In *TAOS*, the Court concluded that the disgorgement from Renesas was not compensatory, reaching that conclusion largely because the jury instructions did not so indicate. There is no similar issue in this case, since there was no jury and therefore no jury instructions.

E. The Court Should Also Vacate the District Court's Determination of Wilson Wolf's Inventorship Claims Because Wilson Wolf Was Denied Its Constitutional Right to a Jury Trial on Common Issues of Fact

Although there is no right to a jury trial on a § 256 inventorship claim standing alone, where commonality exists between the facts underlying a claim for inventorship and the facts underlying the legal claims already going to a jury, "a jury should determine the facts regarding inventorship" in order to avoid denying a plaintiff's right to a jury trial on legal issues. *Shum v. Intel Corp.*, 499 F.3d 1272, 1279 (Fed. Cir. 2007). *See also Smith Flooring, Inc. v. Pennsylvania Lumbermens Mut. Ins. Co.*, 713 F.3d 933, 937 (8th Cir. 2013) ("[T]he normal practice is to try both claims to a jury. In this way, the jury's verdict will conclusively settle these common issues, and only issues peculiar to the equitable claim will be left to be decided by the judge," *quoting Brownlee v. Yellow Freight Sys., Inc.*, 921 F.2d 745, 749 (8th Cir.1990)). Here, the jury's determination of Wilson Wolf's contract and trade secret misappropriation claims will necessarily inform Wilson Wolf's inventorship claim. Accordingly, the jury should hear and decide the factual issues that underlie Wilson Wolf's inventorship claim.

Because the denial of Wilson Wolf's constitutional right to a jury trial requires that this matter be remanded to the district court for a jury trial on all issues, the district court's holding that it did not have subject matter jurisdiction to

decide the inventorship claim at trial is moot. *See* Appx91-92. The district court's holding was based on its determination that the named inventors on the patents at issue did not have the opportunity to be heard at trial, because they were sequestered. *Id.*, *citing* 35 U.S.C. § 256(b). Because this matter must be retried to a jury, whether the named inventors had an opportunity to be heard at the bench trial is irrelevant. So long as the named inventors are given notice and an opportunity to be heard during the required jury trial, Section 256(b) will be satisfied.

F. The Court Should Also Vacate the District Court's Determination of Corning's Defenses

Finally, for these same reasons related to the right to a trial by jury, the Court should vacate the district court's determination of Corning's laches and statute of limitations defenses.

The laches determination must be vacated for the very reasons discussed above: there are common factual issues underlying Corning's laches defense and Wilson Wolf's legal claims. Therefore, the district court was obligated to allow the jury to make its factual determinations first, before the judge made any additional determinations. *Sturgis Motorcycle Rally, Inc. v. Rushmore Photo & Gifts, Inc.*, 908 F.3d 313, 343 (8th Cir. 2018).

For example, laches is based on a factual determination about steps that were taken (or not taken) by the plaintiff, and whether those steps created reasonable or

unreasonable delays of the filing of the Complaint and the pursuit of damages. That factual determination overlaps significantly with the factual determination of the contract and trade secret claims. Similarly, laches is not available to a party with unclean hands. The unclean hands doctrine "closes the doors of a court of equity to one tainted with inequitableness or bad faith relative to the matter in which he seeks relief." *Jarrow Formulas, Inc. v. Nutrition Now, Inc.*, 304 F.3d 829, 841 (9th Cir. 2002). Simply put, a party with unclean hands may not assert laches. *Id.*; *Hot Wax, Inc. v. Turtle Wax, Inc.*, 191 F.3d 813, 825 (7th Cir. 1999). While Corning's misappropriation is itself distasteful, "unclean hands" requires something more. That factual determination based on Corning's egregious misconduct overlaps significantly with the detailed sequence of events developed for the contract and trade secret battles. Thus, the district court cannot properly determine Corning's laches defense unless and until Wilson Wolf's claims are tried to the jury, and the jury is permitted to decide these common factual issues.

The Court should also vacate the district court's determination of the statute of limitations defense because such defenses must be submitted to the jury in cases where there is a jury deciding the related claims. "Statute of limitations is a defense, and in a case in which a party is entitled to, and demands, a jury trial,

defenses are tried to the jury along with the case in chief." *Begolli v. Home Depot U.S.A., Inc.*, 701 F.3d 1158, 1160 (7th Cir. 2012).

G. The Court Should Also Vacate the District Court's Interpretation of the Parties' Confidential Disclosure Agreement

As explained above, because the district court deprived Wilson Wolf of its constitutional right to a jury trial, this Court should vacate the district court's Opinion in its entirety. That includes any legal conclusions reached by the district court during or after the impermissible bench trial. Specifically, this Court should vacate the district court's interpretation of the CDA between Wilson Wolf and Corning. This Court reviews the interpretation of a contract de novo. *Trireme Med., LLC v. AngioScore, Inc.*, 812 F.3d 1050, 1053 (Fed. Cir. 2016).

In its recitation of its factual findings, the district court stated that the "CDA imposed no restrictions on the use of information taken from the public domain or information that a party independently developed." Appx32. This interpretation is contrary to the express language of the CDA. Although, by its terms, the CDA has exceptions for information that was in the public domain or independently developed, the CDA requires that any party using information designated as "Confidential Information" on these bases must notify the designating party of its intent to rely on these exceptions and must prove its assertions with corroborating evidence. Appx442-443. Wilson Wolf requests, therefore, that this Court make

clear in its order vacating the district court's Opinion that this encompasses also the vacating of the district court's interpretation of the parties' CDA.

II. THIS COURT SHOULD VACATE THE DISTRICT COURT'S HOLDING THAT THE STATUTE OF LIMITATIONS BARS WILSON WOLF'S CLAIMS

The district court abused its discretion when it permitted Corning to amend its Answer after trial to plead a statute of limitations defense.[5] The district court's grant of Corning's post-trial motion was an abuse of discretion because it severely prejudiced Wilson Wolf. This provides an independent basis for this Court to vacate the district court's holding that Wilson Wolf's claims are time-barred.

A. Standard of Review

Because motions to amend pleading are not unique to patent law, this Court applies the law of the regional circuit to this issue. *See*, *e.g.*, *Energy Heating, LLC v. Heat On-the-Fly, LLC*, 889 F.3d 1291, 1303 (Fed. Cir. 2018). The Eighth Circuit Court of Appeals reviews a district court's grant or denial of a motion to amend for

[5] To be clear, after so many years and so many consistent rulings excluding the statute of limitations, Wilson Wolf does not believe that the district court had the discretion to bring the statute of limitations into the case with a post-trial amendment. We therefore believe that the statute of limitations determination should be flatly overturned and not remanded. However, if the Court disagrees, Wilson Wolf believes that the statute of limitations issues must be submitted to the jury.

an abuse of discretion. *Baker v. John Morrell & Co.*, 382 F.3d 816, 830 (8th Cir. 2004).

B. The District Court Abused its Discretion When it Granted Corning's Post-Trial Motion to Amend

1. The District Court's Order Is an Abuse of Discretion Because it Prejudices Wilson Wolf's Action on the Merits

The district court abused its discretion when it permitted Corning to plead its statute of limitations defense after trial because doing so was wildly prejudicial to Wilson Wolf. Wilson Wolf had reasonably relied on multiple rulings from the district court, each consistently holding that Corning could not assert a statute of limitations defense. Wilson Wolf therefore did not gather evidence, and did not gather testimony in depositions, about topics like fraudulent concealment, which would have been exceptionally helpful in responding to a statute of limitations defense. *Wild v. Rarig*, 234 N.W.2d 775, 795 (Minn. 1975) (fraudulent concealment tolls the running of the statute of limitations). By reversing this ruling ***after trial***, the judge created a situation in which Wilson Wolf could not seek supplemental discovery. Moreover, Wilson Wolf was not even able to make its case at trial, because Corning had threatened to file a motion to amend based on "consent" if Wilson Wolf even mentioned topics that would open the door. The district court's decision after trial was thus extraordinarily prejudicial. In building

its case, Wilson Wolf appropriately relied on rulings that for ten years made clear that the statute of limitations was not going to be litigated. Then, in voicing its case, Wilson Wolf had no opportunity to raise even the evidence of fraudulent concealment that did make it into the record as part of other issues, because doing so would have triggered Corning's "consent" trap. The district court's decision must therefore be reversed. If the district court thought it appropriate to litigate this issue, then the issue had to be included in such a way that Wilson Wolf would have been able to fairly develop and present its side of the argument. For all of these reasons, Wilson Wolf was prejudiced by this ruling.

This case presents a unique fact pattern, a fact that even the district court acknowledged. Appx3 ("The Court acknowledges that the procedural posture of these motions is unique."). Corning first raised its statute of limitations defense back in 2013, when it first moved to amend its Answer. *See supra*, p. 15. The district court denied that motion on the grounds that Corning did not demonstrate good cause to amend. *Id.* The district court rejected three subsequent motions to amend before trial. *Id.* Wilson Wolf relied on the district court's exclusion of Corning's statute of limitations defense for almost ***ten years*** in conducting discovery, formulating litigation strategy, and preparing for trial. These are not the circumstances that Rule 15(b) is designed to address; that rule is intended to

address unanticipated issues that arise at trial, not known issues that have already (repeatedly) been addressed. And, regardless of the procedural details, the district court's abrupt reversal of its prior holdings so long after the record was closed severely prejudiced Wilson Wolf, and therefore should be vacated by this Court.

The concrete prejudice suffered by Wilson Wolf as a result of the district court's grant of permission to amend can be illustrated by the issue of fraudulent concealment. Generally, a claim for breach of contract accrues at the time of the alleged breach, but "[a] defendant's fraudulent concealment tolls the statute of limitations until the plaintiff discovers or has reasonable opportunity to discover the concealed facts." *Doe v. Order of St. Benedict*, 836 F.Supp. 2d 872, 876 (D. Minn. 2011). "Fraudulent concealment consists of an intentional and affirmative concealment of the facts which establish the cause of action." *Id.* The "intentional and affirmative concealment" analysis necessary to rebut a statute of limitations defense, ***if that defense had been pled***, would have prompted Wilson Wolf to conduct discovery specifically targeted to Corning's intentional and affirmative concealment of its use of Wilson Wolf's confidential information in developing the HYPER products–including discovery that Wilson Wolf would only have been entitled to conduct if Corning's intent was at issue in the case. At the time Corning filed its first motion to amend in November 2013, there were still nearly seven

months remaining in the period for fact discovery set by the Scheduling Order. *See* Appx562. Wilson Wolf relied on the Magistrate Judge's Order denying Corning's motion to amend, and the district court's affirmance of that Order, in conducting discovery. If the district court had allowed Corning to amend at that point, or if Corning had been diligent in pleading or moving to amend its Answer before the deadline set by the Scheduling Order, Wilson Wolf would have had the opportunity to take full and fair discovery on topics relevant to Corning's intentional and affirmative concealment.

The district court brushed aside this prejudice issue by asserting, without analysis, that Wilson Wolf was not prejudiced because Corning had asserted a laches defense. Appx4. ("Corning pleaded a laches defense, which incorporates facts relevant to the statute-of-limitations defense and squarely placed the timeliness of Plaintiffs' claims at issue."). This ignores, however, the very different standards applicable to the two affirmative defenses. Laches is an equitable doctrine under which the courts "examine all aspects of the equities affecting each case." *Reynolds v. Heartland Transp.*, 849 F.2d 1074, 1075 (8th Cir. 1988). "[T]he practical question in each case is whether there has been such an unreasonable delay in asserting a known right, resulting in prejudice to others, as would make it inequitable to grant the relief prayed for." *Monaghen v. Simon*, 888 N.W.2d 324,

329 (Minn. 2016) (internal quotations omitted). A statute of limitations defense, by contrast, focuses solely on when the claim accrued and whether the prescribed time period has passed.

Wilson Wolf's response to Corning's laches defense was thus very different from what would have been its response to Corning's statute of limitations defense, had the latter been pled. For laches, Wilson Wolf focused on arguments about Corning's unclean hands, the reasonableness of any delay, and the lack of prejudice to Corning.[6] **None of these factors** is relevant to a statute of limitations defense. In contrast, had Wilson Wolf known that the court was going to consider the statute of limitations, Wilson Wolf would have developed evidence of Corning's intentional and affirmative concealment, thereby tolling the clock. The district court's decision to consider the statute of limitations long after the close of discovery, without allowing a continuance to permit Wilson Wolf to conduct discovery and develop the record, thus clearly prejudiced Wilson Wolf.

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[6] Wilson also argued that laches was irrelevant as a matter of law because laches cannot be raised against any claim where the relevant law already offers a statute of limitations defense. (*See infra*, pp. 49-51). And Wilson also argued that laches is an ***equitable*** defense that does not apply to ***legal*** claims, such as the breach of contract and trade secret claims in this case. The presence of laches, therefore, cannot serve as a proxy for the unpled statute of limitations defense.

The district court noted that "Corning put Plaintiffs on notice that it would rely on a limitations defense, and the Court explicitly stated that it would consider an amendment based on the evidence at trial," Appx4, but neither assertion changes the above analysis. These "notices" were given on the eve of trial; by then, it was far too late to give Wilson Wolf a full and fair opportunity to litigate the statute of limitations. Wilson Wolf could not conduct discovery regarding Corning's fraudulent concealment, for instance, nor in other ways suddenly muster the evidence needed to address the issue at trial.

2. The District Court's Grant of Corning's Motion to Amend Was not Harmless Error

The district court held that "there is no evidence that Corning intentionally or affirmatively concealed facts that would establish a cause of action." Appx87-88. And that's exactly the point. Had Wilson Wolf been told that that the statute of limitations was being tried, Wilson Wolf would have developed that record. That is the prejudice that makes the district court's last-minute decision an abuse of its discretion.

This was not harmless error; even in the existing record, there is enough evidence of fraudulent concealment to suggest that Wilson Wolf's discovery regarding this issue would likely have been fruitful. For example, in 2007, Wilson expressed concern to Corning about the confidential information that he had

disclosed to Corning pursuant to the CDA. He contacted Mark Beck at Corning to raise this issue. Beck promised Wilson that he would have Thomas Beall, Corning's in-house counsel, investigate the matter. Appx8437-8438 at 908:22-909:10. Beck later called Wilson–in 2009–and assured Wilson that Corning did not misuse any of Wilson Wolf's trade secrets or confidential information. Appx8794 at 1265:10-20; Appx9132-9133 at 1603:13-1604:1. This effort to conceal Corning's misconduct was patently false. This evidence alone raises the specter of fraudulent concealment by Corning. Had the statute of limitations defense been pled, Wilson Wolf would have conducted additional discovery in order to uncover more facts supporting fraudulent concealment, including discovery into the representations made to Wilson, Corning's internal discussions regarding Wilson's concern and Corning's reaction, and all of the steps taken—or not taken—by Corning to "investigate" Wilson's concerns. And this question—whether Corning fraudulently concealed its trade secret misappropriation and breach of contract—is a fact issue for the jury. *See*, *e.g.*, *Nucor Corp. v. Nebraska Public Power Dist.*, 891 F.2d 1343, 1351 (8th Cir. 1989).

And the determination of the correct deadline under the statute of limitations is also a fact-based inquiry that Wilson Wolf would have addressed. The district court based its ultimate substantive conclusion that the statute of limitations had

tolled on early product launch dates (mostly in 2005) provided by Corning, with no documentary support. But Wilson Wolf believes that those products were not actually launched and displayed publicly until much later. In fact, the evidence suggests that the actual release dates put Wilson Wolf comfortably within the applicable statute of limitations. In other words, this after-trial rethink of the statute of limitations really matters.

The district court erred when it severely prejudiced Wilson Wolf by allowing Corning to add a statute of limitations defense after Wilson Wolf had conducted discovery and prepared its case in reliance on the district court's ten-year history of refusing to allow that defense. Accordingly, this Court should vacate the district court's holding that Wilson Wolf's claims are time-barred.

III. THIS COURT SHOULD VACATE THE DISTRICT COURT'S HOLDING THAT THE DOCTRINE OF LACHES BARS WILSON WOLF'S "DISGORGEMENT" REMEDY

The district court's application of laches to Wilson Wolf's legal and statutory claims constitutes clear legal error. This provides an independent basis for this Court to vacate the district court's holding that Wilson Wolf's disgorgement remedy is barred by laches.

A. Standard of Review

The district court implicitly held that laches is applicable to Wilson Wolf's claims to the extent Wilson Wolf seeks equitable relief. This legal conclusion is reviewed de novo by this Court. *See*, *e.g.*, *Nichia Corp. v. Everlight Americas, Inc.*, 855 F.3d 1328, 1333 (Fed. Cir. 2017) ("We review the court's findings of fact for clear error and its legal conclusions de novo.")

B. Laches is Inapplicable to Wilson Wolf's Claims

As explained above, the district court should not have determined Corning's laches defense without first trying Wilson Wolf's claims to a jury, as the Seventh Amendment requires. *See supra*, pp. 37-38. Even leaving that violation of Wilson Wolf's constitutional rights aside, however, the district court erred in holding that the doctrine of laches bars Wilson Wolf's "disgorgement" remedy.

Laches does not apply to claims subject to a statutory limitations period. *Petrella v. Metro–Goldwyn–Mayer, Inc.*, 572 U.S. 663, 678-79 (2014) ("laches is a defense developed by courts of equity; its principal application [is] to claims of an equitable cast for which the Legislature has provided no fixed time limitation."); *Advanced Cardiovascular Systems, Inc. v. Scimed Life Sys., Inc.*, 988 F.2d 1157, 1161 (Fed. Cir. 1993) ("When a limitation on the period for bringing suit has been set by statute, laches will generally not be invoked to shorten the statutory

period."). "Laches is a gap-filling doctrine, and where there is a statute of limitations, there is no gap to fill." *SCA Hygiene Products Aktiebolag v. First Quality Baby Products, LLC*, 580 U.S. 328, 335 (2017). It is undisputed that Wilson Wolf's contract and trade secret claims are both subject to statutory limitations periods. Appx84 (trade secret claim subject to three year limitations period); Appx87 (contract claims subject to six-year statute of limitations). Therefore, laches is inapplicable to Wilson Wolf's claims, and the district court's application of laches to bar Wilson Wolf's request for disgorgement of Corning's profits is legally erroneous.

The district court implicitly recognized that laches is inapplicable to claims subject to a statutory limitations period, because it applied laches **only to** Wilson Wolf's disgorgement remedy. *See* Appx88 (discussing laches only in relation to "disgorgement remedy"); Appx91 ("these examples demonstrate the existence of evidentiary prejudice sufficient to support a finding that laches bars any equitable relief Plaintiffs seek"). In fact, the district court **did not** apply laches to Wilson Wolf's other remedies. Appx91 ("Plaintiffs seek additional remedies [in addition to disgorgement] for breach of contract. Because Plaintiffs' breach-of-contract fails, they are not entitled to contract remedies.")

But the district court's application of laches to Wilson Wolf's disgorgement remedy is legally erroneous as well. As fully explained above, Wilson Wolf sought "disgorgement" of Corning's profits as unjust enrichment damages, which is a remedy that is expressly permitted by the MUTSA. That unjust enrichment remedy is a legal remedy, not an equitable remedy; therefore, laches is inapplicable.

Accordingly, this Court should vacate the district court's determination that laches bars Wilson Wolf's "disgorgement" remedy.

CONCLUSION AND RELIEF SOUGHT

Wilson Wolf respectfully requests that the Court vacate the Findings of Fact, Conclusions of Law, and Order for Judgment of the district court in its entirety and remand this matter back to the district court for a trial by jury on all issues so triable.

Dated: December 18, 2023

/s/ Devan V. Padmanabhan
Devan V. Padmanabhan
Sri K. Sankaran
Paul J. Robbennolt
Michelle E. Dawson
Erin O. Dungan
Mariah L. Reynolds
Britta S. Loftus
PADMANABHAN & DAWSON, PLLC

9800 Shelard Parkway, Suite 120
Minneapolis, MN 55441
Telephone: (612) 444-3601
devan@paddalawgroup.com
sri@paddalawgroup.com
paul@paddalawgroup.com
michelle@paddalawgroup.com
erin@paddalawgroup.com
mariah@paddalawgroup.com
britta@paddalawgroup.com

Attorneys for Plaintiffs-Appellants Wilson Wolf Manufacturing Corporation and John R. Wilson

ADDENDUM

UNITED STATES DISTRICT COURT

District of Minnesota

John R. Wilson, Wilson and Wolf Manufacturing Corporation,

Plaintiff(s),

v.

Corning, Inc.,

Defendant(s).

JUDGMENT IN A CIVIL CASE

Case Number: 13-cv-210 DWF/TNL

☒ **Decision by Court**. This action came to trial or hearing before the Court. The issues have been tried or heard and a decision has been rendered.

IT IS ORDERED AND ADJUDGED THAT:

1. Judgment shall be entered on Plaintiffs' Trade Secret Misappropriation Claim (Count VI) in favor of Corning and against Plaintiffs.

2. Judgment shall be entered on Plaintiffs' Breach of Contract Claim (Count IV) in favor of Corning and against Plaintiffs.

3. Judgment shall be entered on Wilson's Inventorship Claims (Counts I, II,III) in favor of Corning and against Wilson.

4. Corning's Motions to Amend Answer (Doc. Nos. [917, 960]) are **GRANTED** as provided herein.

5. Counts I, II, III, IV, and VI are **DISMISSED WITH PREJUDICE**.

Date: 9/26/2023

KATE M. FOGARTY, CLERK

UNITED STATES DISTRICT COURT
DISTRICT OF MINNESOTA

John R. Wilson and Wilson Wolf Manufacturing Corporation,

Plaintiffs,

v.

Corning, Inc.,

Defendant.

Civil No. 13-210 (DWF/TNL)

FINDINGS OF FACT, CONCLUSIONS OF LAW, AND ORDER FOR JUDGMENT

The above-entitled matter came before the Court as a bench trial commencing on November 7, 2022, and concluding on Friday, December 2, 2022. Based upon the presentations by the parties, including the extensive testimony of the witnesses and the voluminous exhibits produced at trial, as well as counsels' arguments and post-trial submissions, the entire record before the Court, and the Court being otherwise duly advised in the premises, the Court hereby issues its Findings of Fact and Conclusions of Law pursuant to Rule 52(a) of the Federal Rules of Civil Procedure.

PRELIMINARY MATTERS

A. Corning's Motions to Amend Answer

Defendant Corning, Inc. ("Corning") moves the Court for leave to amend its answer under Rule 15(b)(1) to add an express statute of limitations defense (Doc. No. 917) and separately under Rule 54(c) to allow it to amend the answer post-trial to plead an express statute of limitations defense and/or to enter judgment (Doc. No. 960). Corning submits that it has been raising its limitations defense since 2013 and litigating

laches from the beginning of this lawsuit. Corning argues that as the case expanded, documents made clear that Plaintiffs John R. Wilson ("Wilson") and Wilson Wolf Manufacturing Corporation ("Wilson Wolf") (together, "Plaintiffs") were making threats, raising disputes, and exploring contract and intellectual property claims against Corning as early as April 2005. Moreover, Corning points out that the Court's prior rulings on summary judgment defeated any allegation of "continuing" misappropriation through 2012. Now, Corning argues that the Court should allow an amendment of its answer to add a statute of limitations defense under either Rule 15(b)(1) or Rule 54(c) and to enter judgment in Corning's favor on the state-law claims for trade-secret misappropriation and breach of contract under the applicable statutes of limitations under Rule 54(c).

Plaintiffs oppose the motion, arguing that Corning cannot meet the good-cause standard, particularly after Corning has failed to show good cause for its amendment in prior attempts, and because permitting amendment now would prejudice Plaintiffs. In addition, Plaintiffs submit that Rule 54(c) only provides relief on claims that have been properly pleaded and proved and that Corning did not try the statute of limitations defense because that defense is not identical to laches.

The Court acknowledges that the procedural posture of these motions is unique. Corning last attempted to amend its answer immediately before trial under Rule 15(a). Corning correctly points out that the Court declined to take up the issue at the time but stated that it would consider an amendment "based on the evidence presented at trial." (Doc. No. 862 ¶ 1.)

Rule 15(b)(1) of the Federal Rules of Civil Procedure provides that during and after trial, based on an objection at trial, "[t]he court may permit the pleadings to be amended . . . [and t]he court should freely permit an amendment when doing so will aid in presenting the merits and the objecting party fails to satisfy the court that the evidence would prejudice that party's action or defense on the merits." *See also Baker v. John Morrell & Co.*, 382 F.3d 816, 831 (8th Cir. 2004) (noting that Rule 15(b) allows for amendments before and after trial). Rule 54(c) provides that, except in cases of judgment by default, "[e]very [] final judgment should grant the relief to which each party is entitled, even if the party has not demanded that relief in its pleadings." Fed. R. Civ. P. 54(c). A party, however, "will not be given relief not specified in its complaint where the 'failure to ask for particular relief so prejudiced the opposing party that it would be unjust to grant such relief.'" *Baker*, 382 F.3d at 831 (citation omitted). Prejudice may exist if the pleading failure denies the opposing party the opportunity to make a realistic appraisal of its case, such that its litigation strategy is based on speculation. (*Id*.)

Here, Corning pleaded a laches defense, which incorporates facts relevant to the statute-of-limitations defense and squarely placed the timeliness of Plaintiffs' claims at issue. In addition, Corning put Plaintiffs on notice that it would rely on a limitations defense, and the Court explicitly stated that it would consider an amendment based on the evidence at trial. Plaintiffs did not consent to trying the statute-of-limitations defense. Even so, now that the evidence has been presented, the Court finds that there is no unfair surprise or prejudice to Plaintiffs in allowing an amendment to add a statute-of-limitations defense. Plaintiffs have not been denied an opportunity to make a realistic

appraisal of their case and adjust their litigation strategy. Importantly, Plaintiffs cannot plausibly claim that Corning fraudulently concealed any facts that were intended to leave Plaintiffs in the dark. In fact, the evidence at trial demonstrates that Wilson was aware in 2005 that Corning was proceeding with its own designs and that he raised concerns even then. The Court will, therefore, permit the answer's amendment to add a statute-of-limitations defense, and the Court will consider that defense as part of the issues to be resolved on the evidence submitted at trial. The Court will address the merits of the defense in the findings of fact and conclusions of law below.

B. Evidentiary Matters

Attached to their Responses to Corning's Post-Trial Proposed Findings of Fact and Conclusions of Law, Plaintiffs submitted an additional exhibit, Exhibit 1 to Plaintiffs' Responses to Corning's Findings of Fact. (Doc. No. 992-1.) Because this exhibit was not part of the evidentiary record at trial, the Court declines to admit it now. As such, the Court will not consider the information contained in Doc. No. 992-1. However, the Court notes that even if the Court had considered this submission, the Court's findings and conclusions would be the same.

INTRODUCTION

In this action, Plaintiffs assert state-law claims for breach of contract and trade-secret misappropriation. At the heart of these claims is the assertion that Corning used Plaintiffs' proprietary designs and information to develop and design its HYPER products. Plaintiffs argue that they shared their confidential information with Corning in 2004 and beyond, including at meetings between Wilson and Corning that occurred in

March, August, and December 2004. As detailed in the findings below, however, the trial evidence shows that Corning inventors designed and developed the HYPERFlask and HYPERStack products independently and in doing so Corning did not use any confidential or trade-secret information belonging to Plaintiffs. Instead, the evidence shows that Corning was involved in a development project with a different corporation (TAP) at roughly the same time Corning was separately exploring a business relationship with Plaintiffs, but that Corning did not use any confidential information shared by Plaintiffs in the former project—which ultimately resulted in the creation of the HYPER products. John Wilson also brings three inventorship claims with respect to three Corning patents. Wilson did not prove those claims at trial. Finally, the evidence at trial demonstrates that Plaintiffs' state-law claims are untimely and that Plaintiffs delayed unreasonably and without excuse in bringing this lawsuit, such that Corning has suffered both economic and evidentiary prejudice.

As more fully explained in the findings below, Plaintiffs' claims for breach of contract and trade-secret misappropriation fail on the merits, Plaintiffs' state-law claims are barred as untimely, and even if Plaintiffs had established liability, any available award would be banned by laches. In addition, Wilson's inventorship claims fail.

FINDINGS OF FACT

I. The Parties & Background on Cell-Culture Devices

1. Wilson is the founder and CEO of Wilson Wolf.

2. Wilson Wolf is located in New Brighton, Minnesota.

3. Wilson has a degree in Mechanical Engineering from the University of Minnesota and degrees in Business Administration and Economics from Hamline University.

4. In 1986, Wilson began his career in cell-culture device design as a mechanical engineer at Endotronics, a cell-culture device manufacturing company.

5. In approximately 1997, Wilson founded Wilson Wolf to invent, develop, manufacture, and market static cell-culture devices intended to advance human health care.

6. At Wilson Wolf, Wilson's responsibilities include inventing, developing, and bringing to market Wilson Wolf's cell-culture devices.

7. In the course of Wilson's responsibilities, he has authored and been the principal investigator on Small Business Innovation Research ("SBIR") grants awarded by the National Institute of Health to Wilson Wolf. In particular, Wilson worked on an application for one such SBIR grant aimed at improving the culture and transport of islet cells for islet transplants for those afflicted with Type I diabetes.[1]

[1] As more fully explained below, Plaintiffs did not present evidence that the SBIR application or any documents that contained the substance of the SBIR application was given or shown to Corning. The Court provisionally granted, and now grants, Corning's motion in limine to exclude evidence of the SBIR grant application and its contents. The Court discusses the SBIR grant for background purposes but does not consider its contents as evidence relevant to Plaintiffs' trade-secret or breach-of-contract claims. However, the Court notes that its findings herein would not change even if the Court considered the SBIR's contents.

8. Corning is a global corporation that operates several divisions in areas of technology, including life sciences, display technologies, and environmental technologies.

9. Corning is a leader in the cell-culture industry and employs inventors with experience in the field. These include Greg Martin ("Martin"), Product Development Engineer, and Dr. Allison Tanner ("Tanner"), cell biologist and Development Scientist. At all relevant times, Martin and Tanner were both part of Corning Life Sciences' ("CLS") Science and Technology Development Group.

10. Corning's inventors had experience with many kinds of cell-culturing devices, including those involving gas-permeable materials, multiple layers, and the elimination of the gas-liquid interface. These devices include Corning products such as the CellCube, the CellSTACK, and the RoboFlask.

11. In March 2004, Corning was selling a cell-culture device called the Corning CellSTACK Culture Chambers.

12. Below is a photo of the CellSTACK product:

(PTX 736.)[2]

13. The CellSTACK had gas-permeable material in two caps.

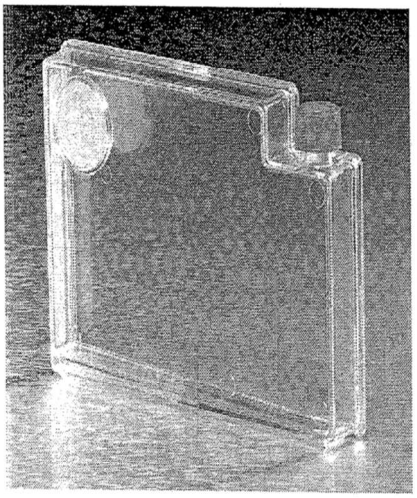
14. The CellSTACK did not have gas-permeable material within the shelves.

15. The CellSTACK relied on the gas-liquid interface to provide oxygen to the cells.

16. As of March 2004, Corning was also about to start selling another cell-culture device—the RoboFlask. Corning's research, development, and manufacture of the RoboFlask vessel was independent of, and well before, any meeting with Wilson.

17. Corning formally launched the RoboFlask in 2004.

18. Below is a photo of the RoboFlask:



(PTX 171.)

[2] The Court notes that it has reproduced images from trial exhibits or from the parties' briefing. The latter may contain added explanations to the images. And in some cases, the Court has altered the size of the images for clarity. They are not meant to be identical representations. The Court cites to Plaintiffs' Trial Exhibits as PTX and Defendant's Trial Exhibits as DTX.

19. Wilson Wolf and Wilson developed a product called the CELLine flask.

20. The CELLine flask is a static cell-culture device that includes a semi-permeable or dialysis membrane to concentrate cell-secreted protein.

21. Wilson was the lead designer and co-inventor for the CELLine flask.

22. Wilson claims to have patents around the CELLine flask.

II. Static Cell-Culture Devices

23. Static cell-culture devices are used to grow cells in a lab for human healthcare, research, and experiments.

24. Cells are cultured, for example, to develop new drugs for treatments for diseases like cancer.

25. To grow cells, cells need to eat and breathe, and therefore cell-culture devices are designed to provide cells with access to nutrients and oxygen.

26. Medium, or media, refers to the liquid or liquids which provide nutrients, such as glucose.

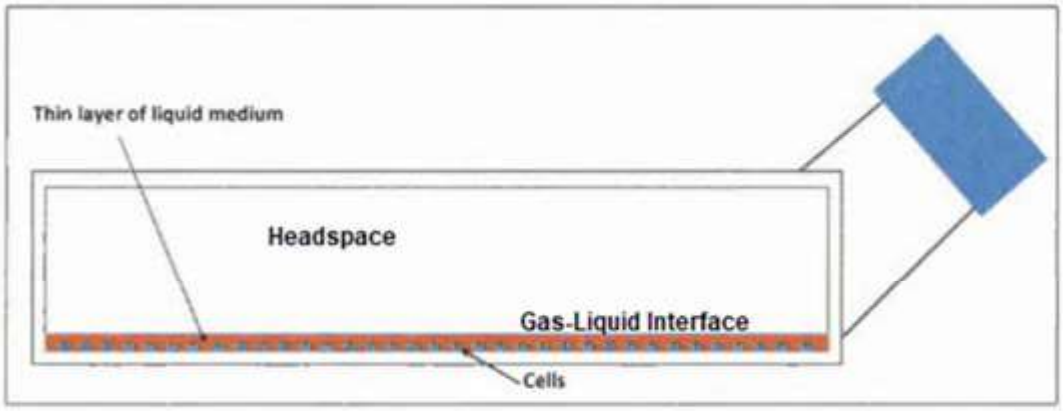
27. "Static" cell-culture devices are capable of functioning in a static mode. A "static mode" is one that does not require ancillary perfusion equipment to pump medium or gas to the cells. The "continuous flow" of liquid nutrient medium through a device is a type of perfusion.

28. Static cell-culture devices that are not compartmentalized by a semi-permeable membrane can provide oxygen from above or below the cells.

29. A typical form of static cell-culture device that provided oxygen from above the medium is the tissue culture flask, which is commonly referred to as the T-Flask.

30. During the relevant time period, and in particular in 2004, Corning and other companies, such as Nunc and Becton Dickenson, were all using the same base product—T-flasks (like Corning's T-175 flask).

31. As shown below, the T-Flask functions with a thin layer of medium below a large volume of gas, commonly referred to as "headspace," from which oxygen travels into the gas-liquid interface of the media to reach cells on the bottom of the flask:



(PTX-735.)

32. As shown above, the cells sit at the bottom of the T-flask device, below a thin layer of liquid medium, and the thickness of the layer of liquid medium is about 3-5 millimeters, the same as two pennies stacked together.

33. One feature of the T-Flask is that the headspace occupies most of the device.

34. Corning's T-Flask has been used in cell-culturing devices for many years and is still used today.

35. Corning's T-175 flask does not have gas-permeable material on the bottom of the vessel.

36. There are no shelves or scaffolds within the T-175 flask.

37. Other multi-shelved or stackable flasks, such as the Nunc TripleFlask, Nunc Cell Factory, and Corning's CellSTACK Culture Chambers, provide more surface area for cell growth than the T-Flask.

38. In 2004, Nunc was selling a device called the TripleFlask.

39. The TripleFlask vessel was very similar to the T-225 (the T-225 shares the same design as the T-175, with a slightly larger growth surface area).

40. The TripleFlask had two additional platforms as compared to the T-225 in a similar footprint to the T-225.

41. The TripleFlask relied on the gas-liquid interface.

42. The TripleFlask could *not* grow ten times the number of cells in the same volume device.

43. During the relevant time period, the industry also used cell-culture bags, which are like zip-lock bags, inside of which you can put liquid.

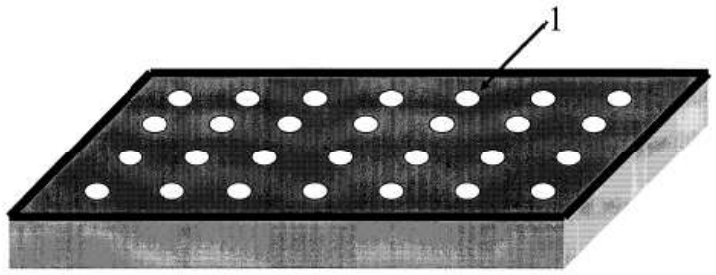
44. Cell-culture bags can eliminate the gas-liquid interface because oxygen can migrate through the film.

III. Corning's HYPERFlask and HYPERStack Products

45. Tanner and Martin developed a multiwell, or microwell, plate between 1999 and 2001 that utilized gas-permeable material.

46. Tanner created the following drawing of the gas-permeable multiwell plate that she and Martin were working on at the time, which shows the bottom view of a multiwell plate that has gas-permeable material on the bottom of the wells:

Gas Permeable Microplate System



Bottom view of microplate

1=Gas permeable material on bottom of microplate covering well areas.

(DTX-36).

47. Tanner and Martin performed experiments with the multiwell plates to determine whether they could grow cells directly on the gas-permeable material in the absence of a gas-liquid interface.

48. They eliminated the gas-liquid interface by applying tape over the top of the wells, which required that the cells obtain oxygen only through the gas-permeable film on the bottom of the wells. They then stacked the multiwell plates one on top of

another with a narrow space for oxygen to travel between each multiwell plate to the gas-permeable material and then diffuse up to the cells.

49. Tanner and Martin confirmed from this experimentation that cells grew well on a gas-permeable film in the absence of a gas-liquid interface.

50. Tanner recorded the results of the experiments in her laboratory notebook.

51. No later than this experimentation in early 2001, long before Wilson ever met with Corning employees, Tanner and Martin knew that a cell-culture device did not require headspace or a gas-liquid interface to culture cells if the device had a gas-permeable cell growth surface.

52. On April 18, 2001, Tanner and Martin filed a patent application related to their work with the multiwell plates, titled Multi-Well Plate and Method of Manufacture. The patent application was published on February 21, 2002, as patent application publication number US 2002/0022219 (the "'219 application").

53. The '219 application confirms Tanner and Martin's knowledge of the use of gas-permeable membranes and no gas-liquid interface in a cell-culture device.

54. At all times relevant to this case, the primary automated cell culturing system on the market was the "SelecT" system, made by the Automation Partnership ("TAP"). It used "T-Flasks" (including Corning's T-175 flask), which have a single layer for cells to grow, as well as double- and triple-layer flasks like the Nunc TripleFlask.

55. TAP is a UK company that manufactures automated cell-culture systems.

56. As part of their longstanding relationship, Corning and TAP had conversations beginning in Fall 2003 about developing a new flask for TAP's SelecT. TAP wanted Corning to develop and commercialize a cell-culture flask that achieved ten times (10x) the cell output from existing single, double- and triple-layer flasks but that would also use a similar flask footprint, so that it could operate on the existing SelecT system. Corning began developing prototypes for TAP, and the parties ultimately entered into a confidentiality agreement.

57. On July 16, 2004, a representative from TAP visited Corning at Corning's Kennebunk, Maine facility. The purpose of the meeting was to allow TAP to "see the facility and to meet with [Corning] to discuss collaborative opportunities." Among others, Jim Buttarazzi, who was the Instrument and Automation Specialist for Corning acting as a liaison with TAP, attended the meeting.

58. After Buttarazzi left the meeting with TAP, he went to visit Tanner and Martin at their desks—Tanner and Martin sat next to each other in a cubicle area—to tell them about a potential new product development project with a customer that Tanner and Martin later learned to be TAP.

59. Buttarazzi explained to Tanner and Martin that Corning had a customer that made automated handling equipment for cell culture and wanted to increase the efficiency of its equipment by using a new higher-yield cell-culture product with the instrument. Buttarazzi asked Martin and Tanner to design a device with a "step change"—or 10x.

60. Martin immediately began to think about how to solve TAP's problem.

61. Martin started with what he already knew. First, the TAP automated equipment currently used T-175 flasks and TAP wanted to increase the cell yield in the same cell-culture device footprint. That meant that a flask design with the same basic shape as the T-175 flask would have to be used.

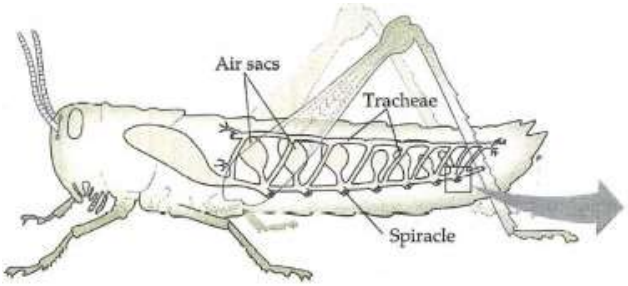
62. Second, one of Corning's competitors, Nunc, manufactured the Nunc TripleFlask, which had a similar footprint as the T-175 flask but with two additional internal shelves, or three total growth surfaces. But while the additional cell growth shelves increased cell production, the Nunc Triple Flask did not meet TAP's demand for ten times the cell yield as the T-175.

63. Martin's "first thought was that [he would] do the same thing [he] did in the multi-well plates." (11/17/22 Tr. 1911:22-1912:5.) That is, he would fill the flasks with multiple chambers using the same thin polystyrene film as the cell growth surface and fill each chamber entirely with media. (*Id.*)

64. Martin was "excited about that as a potential solution" and began to sketch out the design for Tanner on a napkin soon after Buttarazzi left. (11/17/22 Tr. 1912:10-24; 11/21/22 Tr. 2486:13-16.)

65. Martin termed his design the "tracheal" flask because when he stacked the chambers, the thin polystyrene film would reside within the vessel and would be protected by a hard-molded outer wall. To get air from the outside environment to the gas-permeable film, there would be small air gaps below each film layer. This type of design reminded Martin of the respiration system for insects, which Martin had been studying in a biology class. Insects have tracheae to take in oxygen that are fragile and

protected by a hard exterior, as shown in this drawing from Martin's biology textbook:



Martin likened the small exterior openings in the cell-culture device that allowed air to reach the gas-permeable film to tracheal spaces in insects.

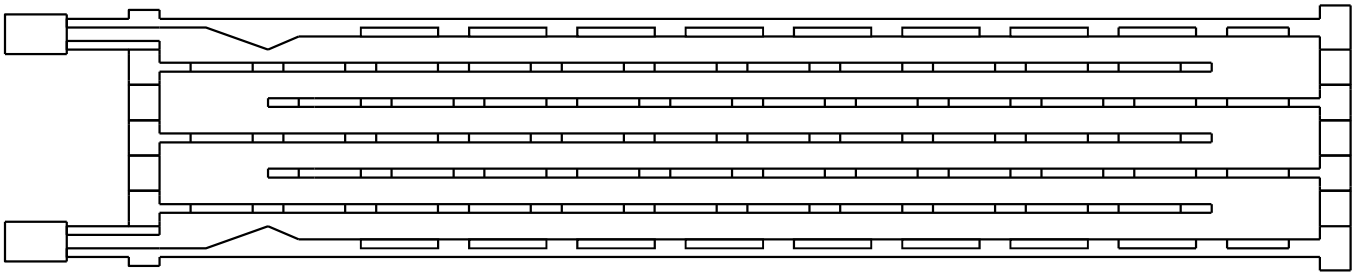
66. Tanner assisted in the adaptations of the tracheal design to a flask structure because that is the format that TAP was using for its automation equipment and contributed numerous other details to the design.

67. Although Martin's original sketch on the napkin from July 16, 2004, could not be located, Martin did document his tracheal-flask design more formally.

68. Specifically, Martin and Tanner created electronic versions of the tracheal flask concept in PowerPoint.

69. There are several copies of slightly different PowerPoint files that contain drawings of the tracheal flask.

70. The first is a native PowerPoint file that contains a single slide with a drawing of the tracheal flask in its most basic form:



(DTX 285.) The metadata for the file indicates that it was created on September 8, 2004, and that it was last saved on September 8, 2004. Thus, the Court finds that this drawing existed as shown no later than September 8, 2004.

71. The month before, on August 24, 2004, Buttarazzi emailed several recipients, including Tanner and Martin, regarding the "collaborative effort with TAP" and asked for input. (PTX 233.) Buttarazzi sent the email across several business platforms at Corning, not just the business managers for cells, because he was exploring product opportunities across several platforms.

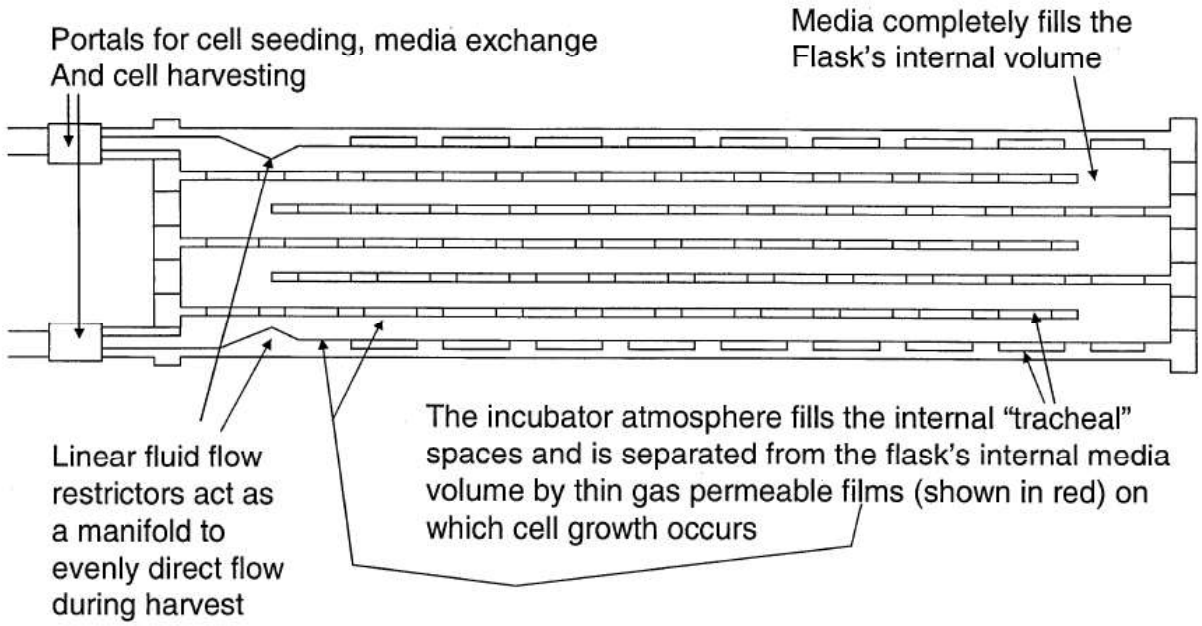
72. On August 27, 2004, Corning held a conference with TAP regarding "collaborative opportunities." (PTX 236.) This meeting was arranged before the meeting between Corning and Wilson on August 25, 2004, and was not related to that meeting.

73. Kim Titus, CLS's Development Manager and Martin and Tanner's supervisor, set up a brainstorming session for TAP SelecT on September 1, 2004. Wilson Wolf's gas-permeable product concepts were listed on the agenda to consider.

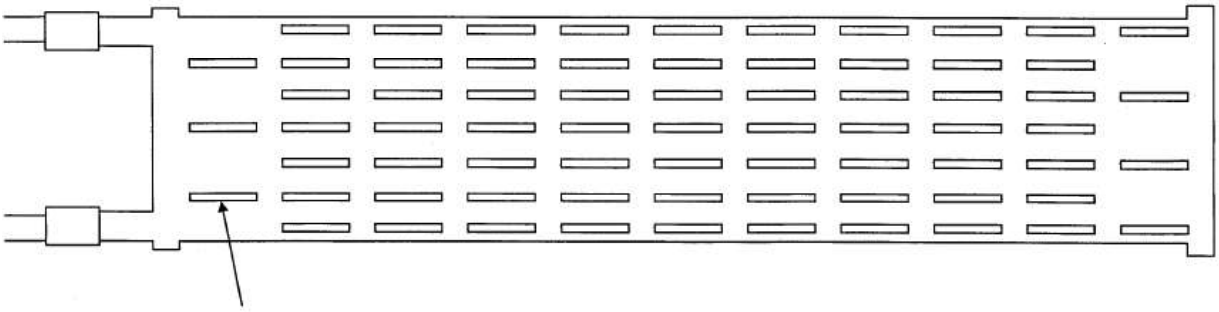
74. Tanner provided an overview for the TAP SelecT team, including a one-page summary of Wilson Wolf's gas-permeable product concepts. Tanner did not provide specifics regarding Wilson Wolf designs or patents. (PTX 276.)

75. On September 9, 2004, Martin emailed Titus a PowerPoint file titled "TAP flask.ppt." The PowerPoint contained several drawings from both Martin and Tanner, including three drawings of Martin's tracheal design: the internal view shown (with the addition of labels), an external view showing the tracheal openings from the outside, and drawings of the individual trays or cell culture compartments.

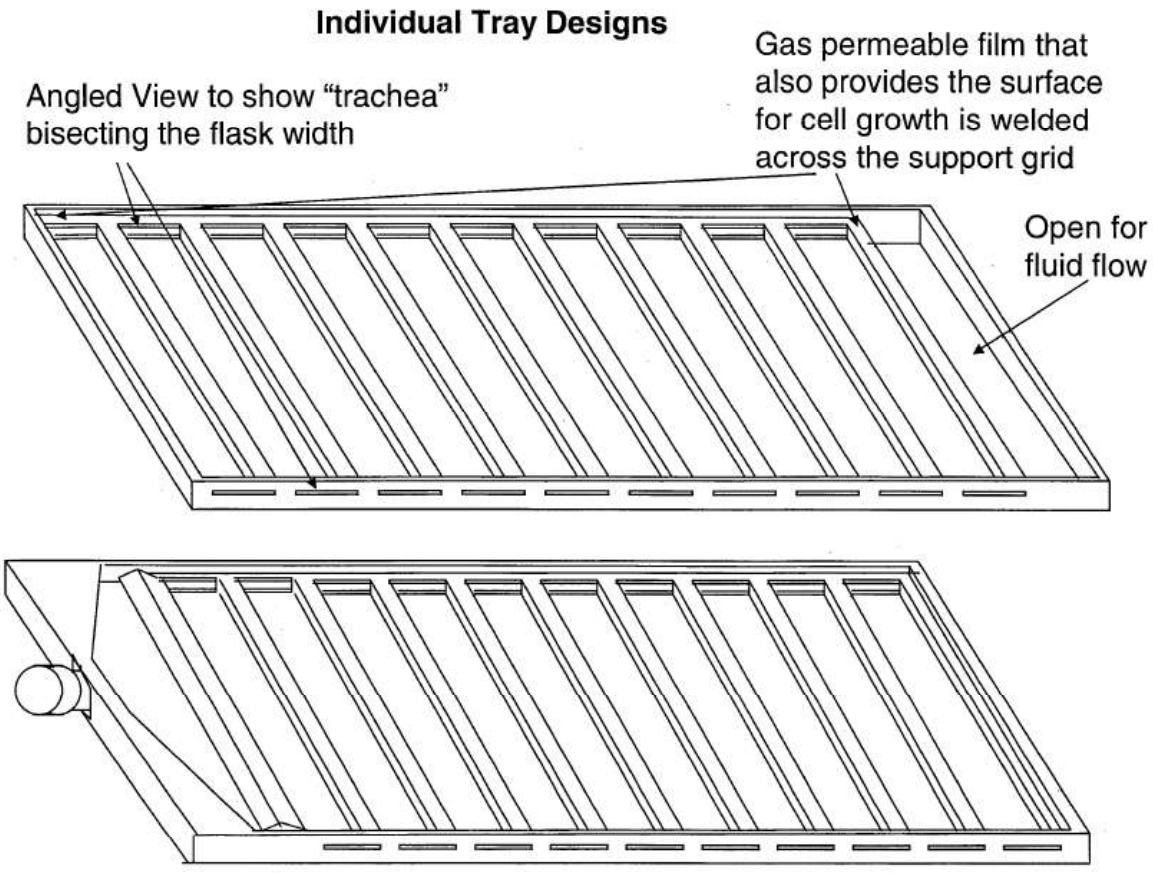
Internal View of Expanded Surface Area Flask



External View Showing "Tracheal" Openings



"Tracheal" portals along the flask's long sides allow for exchange of oxygen and carbon dioxide between the respiratory surfaces that the cells grow on and the incubator atmosphere



(DTX-12.)

76. Immediately after sending the email with the PowerPoint drawings attached, Martin printed a copy and took it to Titus's office to explain the drawings to her in person. Martin talked about each drawing with Titus, including the three tracheal design drawings shown above.

77. Both Martin and Titus testified that the PowerPoint drawings in Defendant's Exhibit 12 were in fact the PowerPoint drawings that were attached to the email sent and received on September 9, 2004.

78. Further, in 2007, Tanner and Martin were searching for documents related to the conception of the tracheal-flask design and located the original September 9, 2004

email and attachment in Martin's email inbox. Martin forwarded the email and attachment to Tanner, who then forwarded it to a Corning in-house attorney.

79. Both Tanner and Martin testified that the original electronic version of the September 9, 2004 email and attachment that was located in 2007 is the same as the paper copy introduced at trial as Defendant's Exhibit 12.

80. There were two additional versions of the PowerPoint file introduced at trial: Plaintiff's Exhibits 140 and 143. Both versions had a created date of September 7, 2004, and a last modified date of January 29, 2005. At the time of trial, almost 18 years later, Tanner did not recall why those files were modified in January 2005. Tanner speculated that because January 28, 2005, was around the time that she and Martin were preparing their invention disclosure, she could have opened the file for that purpose.

81. In any event, the metadata from January 2005 does not contradict either the documentary or the testimonial evidence concerning the creation of the PowerPoint slides in the summer of 2004 or the emailing of the PowerPoint slides with descriptions of the designs to Titus on September 9, 2004.

82. Corning held its first internal team meeting for the formal TAP project (or High-Density Cell Culture Vessel (HDCCV project)), referred to as a TAP Technical Team meeting, on or around December 14, 2004. TAP Technical Team members included Tanner, Martin, Dr. Todd Upton, Joe Wall, Buttarazzi, and Paul Gagnon.

83. Over the course of the next several months, the TAP Technical Team took Martin's tracheal-flask design and developed, tested, and perfected what ultimately became the HYPERFlask vessel.

84. After a year of development and testing, Martin and Tanner sought patent protection for their tracheal-flask design, filing their provisional patent application on July 26, 2005, U.S. Provisional Application No. 60/702,896 (the '896 provisional application"). (DTX-195.)

85. On May 11, 2006, Corning filed Application No. 11/433,859 (the "'859 application"). (PTX 240.)

86. The '859 application issued as U.S. Patent No. 7,745,209 (the "'209 Patent") on June 29, 2010.

87. The named inventors of the '896 provisional application, the '859 application, and the '209 Patent are Gregory R. Martin and Allison J. Tanner.

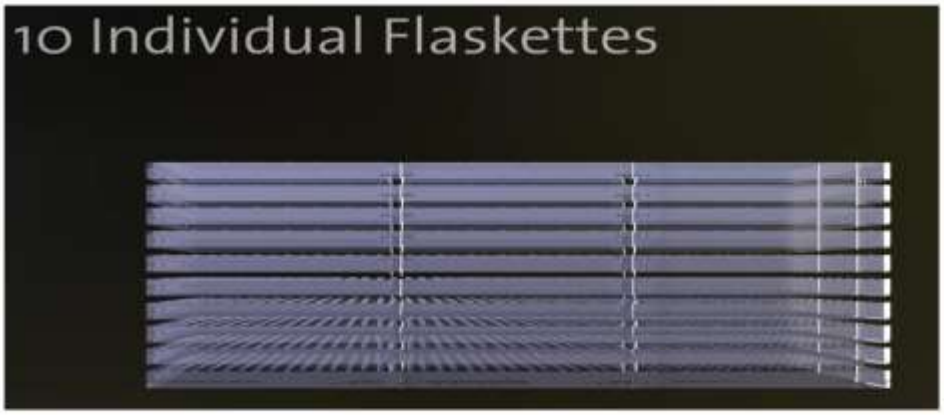
88. Wilson is not a named inventor of the '896 provisional application, '859 application, or the '209 Patent.

89. Corning's patent application related to the HYPERFlask product—which yielded both the '209 and '572 patents—became public on February 1, 2007. (PTX 116.)

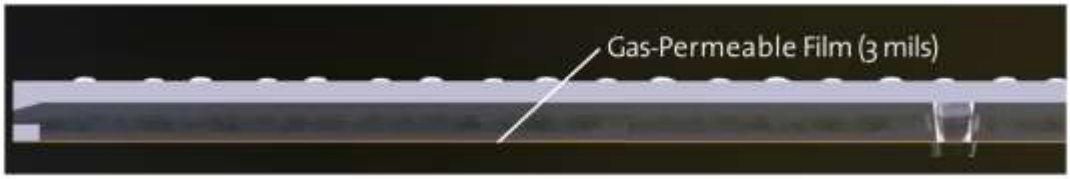
90. Corning introduced its HYPERFlask vessel to the public at a trade show in September 2006.

91. Following the September 2006 introduction, Corning displayed the HYPERFlask device at the ASCB trade show in December 2006, and formally launched the product in May 2007.

92. The HYPERFlask vessel features ten "flaskettes" stacked on top of each other. Each flaskette is a separate compartment for growing cells:

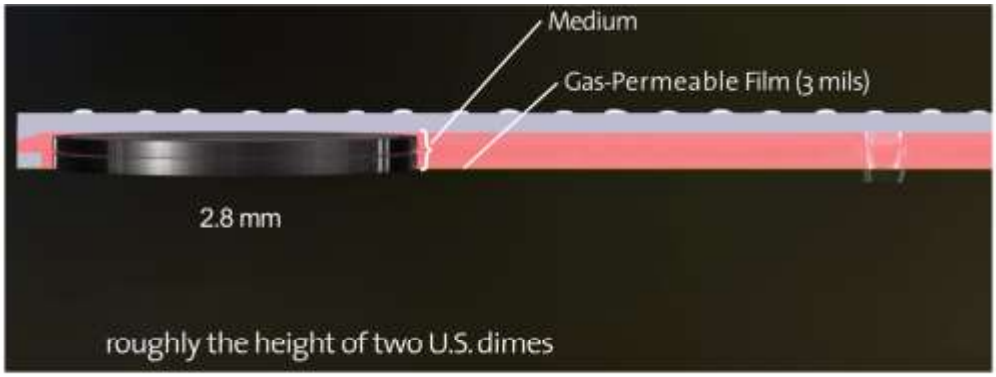


93. At the bottom of each flaskette is a thin, gas-permeable membrane. Cells grow on top of this membrane.



94. The gas permeable material is protected by the hard plastic exterior of the device.

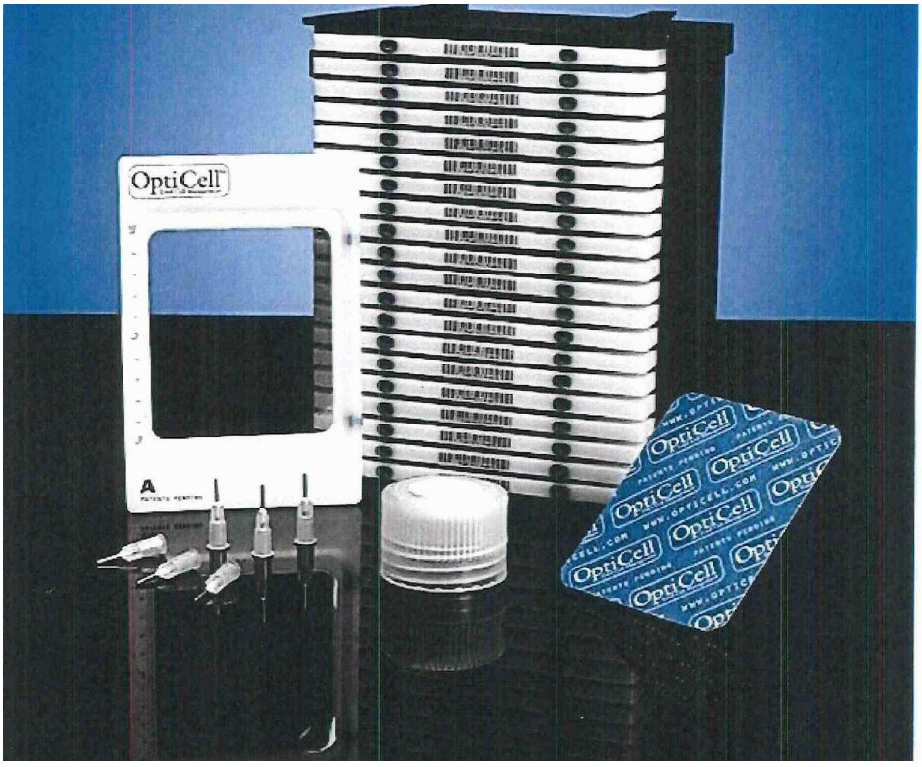
95. To nourish the growing cells, liquid nutrient "medium" fills the compartment above the membrane to a depth of 2.8 millimeters. There is no gas-liquid interface in the compartments.



96. In the space below each membrane is a layer of air, supported by "tracheal" openings to allow the air to enter. Oxygen can penetrate the membrane to reach the cells, allowing them to grow.

97. The HYPERFlask design was based on prior art concepts. Key elements used in this design were known in the prior art well before 2004.

98. A cell culture device that utilized the basic features of the HYPERFlask vessel was already on the market—the OptiCell.



(DTX 24.)

99. The OptiCell was on the market before Wilson filed his provisional patent application, U.S. Provisional Application No. 60/590,651 (the "'651 provisional application") (discussed below), and before Wilson met with anyone from Corning.

100. The commercially available OptiCell was well-known in the industry and known to Corning's employees, including Tanner and Dr. Todd Upton, an Applications Scientist at Corning, before Wilson's '651 provisional application was disclosed.

101. Specifically, Upton testified that he had worked at Cytomatrix for approximately 7.5 years, from about 1996 until March 2004, when he came to work at Corning.

102. While at Cytomatrix, Upton used many devices to culture cells and was involved in hands-on cell culturing research nearly every day.

103. Upton was familiar with the cell-culturing products that were available in the marketplace during his time at Cytomatrix.

104. Upton used the OptiCell device at Cytomatrix.

105. The OptiCell device had gas-permeable membranes.

106. The OptiCell device had multiple cartridges for cell growth that could be placed into a cassette frame.

107. Each cartridge in the OptiCell had two thin gas-permeable films that formed the top and bottom of the cartridge, and the cells grew on both gas-permeable films.

108. Each cartridge in the OptiCell device is very thin, such that the space between the membrane is only about 2-3 millimeters.

109. The OptiCell eliminated the gas-liquid interface: the interior of each cartridge would be filled entirely with media between the two thin gas-permeable films.

110. The OptiCell used spaces between the cartridges to allow oxygen to get to and flow through the gas-permeable membrane to the cells.

111. The OptiCell also was described in printed prior art references, including in U.S. Patent No. 6,455,310 ("Barbara-Guillem").

112. Barbera-Guillen, which describes the OptiCell, disclosed that the individual cell-culture cartridges can be manifolded together so the cell culture medium can be supplied to multiple cell-growth chambers at one time. Tanner also testified that the OptiCell cartridges can be manifolded together.

113. U.S. Patent No. 6, 759,245 ("Toner"), which issued on July 6, 2004, disclosed the use of multiple individual cell-culture compartments that contained gas-permeable material on the bottom of each compartment on which cells would grow in the absence of a gas-liquid interface. The individual cell-culture compartments in Toner were manifolded together. Toner discloses the use of these features in a static device. (*See* DTX-3 at 19:30-41 ("The biological liquid 11 . . . the cells 40 . . . gas-permeable, liquid-impermeable membrane 30") & Fig. 8a.)

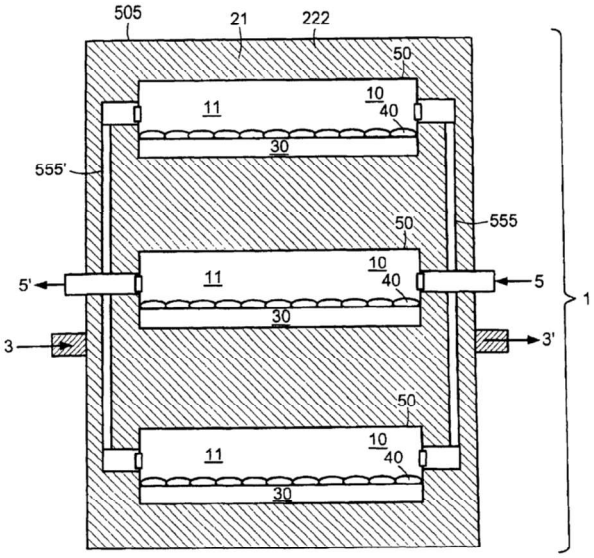


FIG. 8a

114. At least a third prior art patent, U.S. Patent No. 6,855,542 ("DiMilla"), also described multiple individual cell-culture chambers with thin, gas-permeable films as the bottom growth surface. DiMilla teaches that multiple cell-culture chambers could be manifolded together. The cell culture device disclosed in DiMilla is a static device.

115. The building blocks of the HYPERFlask vessel—cells growing on gas-permeable material, no gas-liquid interface, individual cell compartments manifolded together, and air spaces in between multiple cell compartments—were all known in the art before Corning conceived of the tracheal flask concept and before Corning's interactions with Wilson.

116. In 2008, Corning began a project to design the HYPERStack product. The HYPERStack product resulted from a Corning CellStack vessel customer asking if Corning could develop a product that had more layers within the same CellStack vessel volume.

117. The HYPERStack vessel utilizes the same materials and design features as the HYPERFlask vessel, just in a different vessel format. Each HYPERStack vessel "module" consists of 12 individual cell culture chambers. Users can stack multiple modules to meet their needs, thus creating a 24-layer vessel, a 36-layer vessel, etc. The manifolds for each module are designed so that they can be coupled and the entire vessel can be filled or emptied at once.

118. The individual cell culture chambers in the HYPERStack vessel are referred to as "stackettes." Each stackette has a thin gas-permeable polystyrene film on the bottom, which acts as the cell-growth surface, just like the HYPERFlask vessel. Media fills each cell-culture chamber, or stackette, entirely and there is no gas-liquid interface.

(DTX 54.)

119. Just as the HYPERFlask vessel was designed to produce greater cell yield in the same footprint as the T-175 flask, the HYPERStack vessel was designed to produce greater cell yield in the same footprint as the CellStack product.

120. Corning launched the HYPERStack product in 2011.

121. Corning's patent application underlying U.S. Patent No. 8,178,345 (the "'345 patent") entitled *Multilayer Cell Culture Vessels*, became public on December 3, 2009. (PTX 118.)

122. The conception of the tracheal flask, as reflected in Defendant's Exhibit 12, occurred before either Tanner or Martin ever met, communicated with, or interacted with John Wilson.

123. Neither Tanner nor Martin had received Wilson Wolf Confidential Information before they conceived of the tracheal flask.

124. The Court finds Tanner's and Martin's testimony on this issue admissible and credible.

125. In fact, during the Summer of 2004—the relevant time period—Wilson did not communicate with Martin.

126. Although Tanner had limited interactions with Wilson in late August and again in December of 2004, there is no evidence that Wilson provided Tanner any information that contributed to the conception of the tracheal-flask design. The tracheal-flask design was conceived in July 2004 and was significantly different than anything that Wilson presented to Corning.

127. Tanner and Martin did not use any Wilson Wolf designs or other Confidential Information in their design of the HYPERFlask and HYPERStack products.

IV. Wilson's Interactions with Corning, the CDA, and Information Shared Pursuant to the CDA

December 2003 Trade Show

128. Representatives of CLS first met John Wilson at a trade show in San Francisco in December 2003 where Wilson was operating a booth.

129. Corning representatives stopped by a booth Wilson operated because they noticed a Corning roller bottle that looked like it had been altered.

130. At the table, Wilson was exhibiting Wilson Wolf's CELLine product and a prototype of the Vertical Bag. Wilson's Vertical Bag prototype was built by purchasing a Corning roller bottle, cutting off the bottom, and replacing it with gas-permeable silicone rubber.

131. At the trade show, Wilson Wolf invited Corning to visit Wilson Wolf in Minnesota to discuss Corning's manufacturing capabilities and products that Wilson Wolf wanted to develop.

CDA

132. On or around January 6, 2004, Corning and Wilson Wolf entered into a Confidential Disclosure Agreement ("CDA"). (PTX-21.)

133. The CDA is a valid contract.

134. The CDA included a Minnesota choice-of-law provision, was drafted by Corning, and was printed on Corning letterhead.

135. The CDA permitted "exchanges of information which may be confidential for the purpose of enabling [Wilson Wolf] to provide design, engineering or other services for Corning."

136. The CDA stated that "'Confidential Information' shall mean only that information related to selling, inventing, and developing cell culture devices and processes for growing cells disclosed in Corning's sole discretion by Corning to [Wilson Wolf] hereunder, and information related to expertise in inventing and developing cell culture devices and processes for growing cells disclosed in [Wilson Wolf]'s sole discretion by [Wilson Wolf] to Corning hereunder."

137. The CDA provided that: "All Confidential Information shall be disclosed to the receiving party in a writing reasonably identifying it as confidential or, if first orally or visually disclosed, shall be identified as confidential in a writing delivered to the receiving party within thirty (30) days of first oral or visual disclosure."

138. Wilson had entered into other confidentiality agreements with other third parties.

139. The CDA protected only the information that meets the definition of "Confidential Information" and that Wilson Wolf marked with a "confidential" designation either at the time of disclosure or within 30 days of an oral or visual disclosure.

140. The CDA prohibited any use of Confidential Information disclosed and designated by Wilson Wolf "for a period of five (5) years from the date of disclosure."

141. The CDA imposed "no restriction, express or implied, on the disclosure or use of . . . information other than Confidential Information." Thus, the CDA imposed no restrictions on the use of information taken from the public domain or information that a party independently developed.[3]

142. The CDA contained no obligation to use any Confidential Information provided under the CDA and no agreement to commercialize any of Wilson Wolf's designs or ideas disclosed according to the CDA.

143. The CDA also contained a merger clause demonstrating that it was the "entire understanding" between the parties and stating that there could be no amendment or modification without being set forth in a writing signed by both parties.

144. The CDA "comprehensively governs the exchange of information between the parties."

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[3] Plaintiffs submit that this finding is inconsistent with the Court's prior rulings regarding the CDA. The Court disagrees. The Court previously denied summary judgment on Plaintiffs' breach-of-contract claim based on the alleged misuse of Confidential Information. (Doc. No. 461.) At that stage of the litigation, the Court concluded that fact issues remained and that a reasonable jury could find a breach of the CDA. In a subsequent order, the Court again denied summary judgment on the breach-of-contract claim, wherein the Court addressed, among other things, whether the CDA required Confidential Information to be patented or patentable. (Doc. No. 610 at 10.) At that stage, the Court explained that the CDA defined "Confidential Information" more broadly than that ("information relating to expertise in inventing and developing cell culture devices and processes for growing cells") and, viewing the evidence in the light most favorable to Plaintiffs, found issues of material fact as to whether certain information qualified as Confidential Information under the CDA. Confidential Information cannot, however, be defined so broadly so as to encompass information already within the knowledge of Corning or in the public domain. Such information is not covered by the CDA.

145. With the CDA in place, Wilson and Corning scheduled a meeting at Wilson Wolf's headquarters in New Brighton, Minnesota, for March 3, 2004.

146. As discussed above, as of March 2004, Corning and other companies were all using the same base product—i.e., flasks like the Corning T-175 flask.

147. The industry also used cell-culture bags.

March 2004 Meeting

148. On March 3, 2004, Corning representatives met with Wilson at Wilson Wolf's office in New Brighton, Minnesota.

149. The Corning representatives who attended were Dr. Deb Hoover, a lead scientist at Corning and Applications and Late-Stage Development Manager, Lydia Kenton Walsh, Business Manager of Cell Culture Vessels, and Mark Beck, Business Manager for CLS.

150. At the meeting, Wilson provided materials marked "Confidential."

151. Wilson asserts that he provided Corning with a Confidential Product Overview. Walsh, Hoover, and Beck, however, either were not asked about this document or could not recall receiving a copy of such document at the meeting.

152. Wilson asserts that the Product Overview explained his discoveries and contained various designs using Wilson's innovations in cell culture. Corning disputes this and counters that the Product Overview merely offered a high-level statement about the types of concepts that Wilson had, but that it did not provide any designs, proof of concept, or any other specificity about any such concepts.

153. Considering all of the evidence, the Court finds that Corning's testimony regarding the specificity (or lack thereof) of Wilson's Product Overview is credible.

Alleged Items Shared Under the CDA

154. Wilson Wolf contends that it shared five key items with Corning under the CDA: (1) the Vertical Bag; (2) the Wilson Wolf Multilayer Flask ("WW Multilayer Flask"); (3) other Wilson Wolf designs; (4) the '651 provisional application and '814 patent application; and (5) the SBIR application. Significantly, however, the evidence at trial shows that none of these items were used by Corning in developing the HYPER products.

(Vertical Bag)

155. The Vertical Bag refers to a Wilson Wolf cell-culture device. The Vertical Bag was a standard roller bottle with silicone, a gas-permeable material, at the bottom to permit oxygen to reach the cells being grown in the device.

156. The Vertical Bag was designed for use with suspension cells. Suspension cells are cells that do not adhere to the surface of a cell culture device but instead are suspended in media. Adherent cells adhere to the surface of cell culture devices. The Vertical Bag is not used to grow adherent cells.

157. The Vertical Bag differs from Corning's HYPERFlask in several respects:

Vertical Bag	HYPERFlask Device
One large cell culture compartment	Ten individual cell culture compartments
High media height (greater than 5cm)	Conventional, low media height (2.8 mm)

Vertical Bag	HYPERFlask Device
Thick silicone gas-permeable material	Thin polystyrene gas-permeable film
Gas-permeable material on the exterior, bottom of device	Gas-permeable material on the inside of the device forming the bottom surface of each cell-growth compartment
For use with suspension cells	For use with adherent cells

158. At the December 2003 trade show, evidence shows that Wilson displayed this Vertical Bag design—a Corning Roller Bottle cell-culture device with the bottom cut off and replaced with gas-permeable silicone rubber. Wilson was displaying this device publicly.

159. Corning's Walsh—then a business manager in the CLS division—saw the device that Wilson displayed. She identified the bottle that she saw as a Corning roller bottle with the bottom cut off and replaced with thick silicone rubber—Wilson Wolf's Vertical Bag design.

160. Walsh's testimony is corroborated by other Corning witness testimony. Although Wilson testified that the device he publicly displayed at the trade show was a different product that he termed a "membrane-based roller bottle," his testimony is not as credible as Walsh's testimony. The Court accepts Walsh's testimony and finds that Wilson displayed his Vertical Bag design at the trade show.

161. Because the Vertical Bag design was displayed publicly at the trade show, neither the gas-permeable material feature nor Wilson Wolf's Vertical Bag design can be a trade secret or purported Confidential Information in this litigation.

162. Initially, employees in Corning's Business Development Group were interested in the Vertical Bag.

163. In March 2004, Hoover was "intrigued by the vertical bag" and "the density of cells that you could get per centimeter squared without refeeding." (11/16/22 Tr. 1706:6-14.) Based on her initial impression, she testified that she could have thought that the Vertical Bag had the potential to "change the face of cell culture." (*Id.*)

164. In April 2004, Wilson Wolf provided Corning with two Vertical Bag prototypes and two membrane-based roller bottle prototypes. Wilson identified the Vertical Bag as Confidential.

165. In April 2004, Wilson obtained Upton's fax number and sent Upton a drawing of the device. Wilson stamped the document "CONFIDENTIAL."

166. Wilson wrote: "Todd-one of these flasks cultures an equivalent number of cells as 10-12 T175 flasks." Corning asserts that this statement was marketing hype.

167. Corning tested Wilson's Vertical Bag prototypes in the summer of 2004.

168. The tests showed that the Vertical Bag worked as Wilson had described.

169. Although the Vertical Bag worked, Corning decided not to go forward with developing it as a commercial product. That decision was made by Corning's senior leadership.

170. After Corning's evaluation of the Vertical Bag, Hoover ultimately did not conclude that the Vertical Bag could "change the face of cell culture." Instead, Corning determined that Wilson's products, including the Vertical Bag, were "niche products and the opportunities for these offerings were limited." (11/16/22 Tr. 1720:19-1721:8.)

171. Upton believed that the Vertical Bag performed exactly the same as the VectraCell Bag, a commercially available product from one of Corning's competitors. Upton's handwritten notes on a letter from Wilson, such as "big picture -->fundamental discovery the way TC [traditional culture] devices are made," were statements that Wilson made when describing the Vertical Bag to Upton and which Upton wrote down. They did not reflect Upton's evaluations or conclusions about Wilson's product concepts.

172. Notably, Corning primarily manufactures and sells cell-culture devices for adherent cells. The Vertical Bag was a niche product for suspension cells, and thus not a fit with Corning's cell-culture business.

173. Plaintiffs eventually commercialized the Vertical Bag concept, which Wilson Wolf sells as the G-Rex. The G-Rex has been a successful product for Plaintiffs, with approximately $70 million in annual sales. Evidence shows that the later success of the G-Rex was due to increased interest among researchers for culturing T cells, for which the G-Rex was useful; this market did not exist at the time that Wilson shared the Vertical Bag with Corning in 2004.

174. Corning did not use the Vertical Bag in the conception or development of the HYPERFlask and HYPERStack products. The Vertical Bag is a completely different design used for different types of cells than the Corning HYPER products.

175. Moreover, evidence shows that Tanner and Martin had not seen the Vertical Bag prototype or design before they conceived of the tracheal flask design in mid-July 2004, and therefore could not have used the prototype.

176. Hoover did discuss the Vertical Bag with Upton, both of whom were in the Business Operations group at CLS (while Tanner and Martin were in the Product Development group). Hoover, however, did not discuss the Vertical Bag or Wilson with Tanner or Martin. In addition, Hoover was not part of the TAP technical team or the HDCCV project and was not a member of the product development team that resulted in the HYPERFlask product.

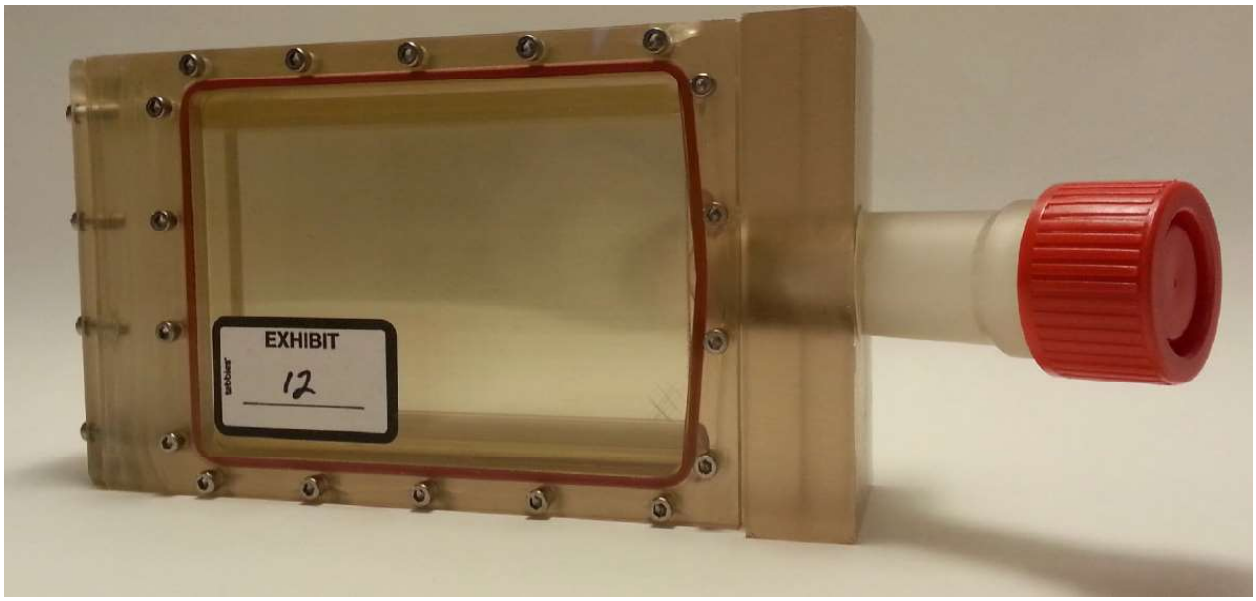
177. Aside from discussing test results for the Vertical Bag at an August 25, 2004 meeting between Corning and Wilson, Upton did not discuss the Vertical Bag with Tanner.

178. Hoover confirmed that when Corning began having discussions with Wilson, both Tanner and Martin already were separately and independently "exploring other types of multi-layer, you know, higher density cell culture devices." Hoover testified that Wilson did not "contribute[] anything that was not already going on" and being developed at Corning, and that his product concepts were not part of the HDCCV project "[b]ecause the HDCCV was a different device. It was a styrene-based multi-layer flask."

179. There was no disclosure of the Vertical Bag to Tanner before the meeting with Wilson on August 25, 2004. Plaintiffs presented no evidence that the Vertical Bag was ever disclosed to Martin.

(Gas Transfer Fixture/Multi-Layer Flask)

180. The second item that Wilson shared with Corning was a set of prototypes of a multilayer flask, or the WW Multilayer Flask/Gas Transfer Fixture:



(PTX-158.)

181. On May 10, 2004, Wilson sent Corning two Gas Transfer Fixtures ("GTF")—that Wilson contends were multilayer flasks. Corning asserts that these were not working multilayer flasks. These were designated as confidential.[4]

182. The WW Multilayer Flask had roughly the same footprint as Corning's T-175 flask, had a neck similar to a T-175 flask, and was made out of polycarbonate material. It had silicone, gas-permeable material, on the end of the flask opposite the neck. The prototypes that Wilson sent Corning had five cell growth layers, or shelves, that were made out of hard plastic material.

[4] The Court refers to GTF and the WW Multilayer Flask interchangeably.

183. The HYPERFlask and HYPERStack products have many features that the WW Multilayer Flask did not have, and differ in many important respects, including:

WW Multilayer Flask	HYPERFlask Device
No individual cell culture compartments; single compartment	Multiple individual cell culture compartments
Non gas-permeable material on inside of vessel	Gas-permeable material on inside of vessel
No cells grow on gas-permeable material	Cells grow on gas-permeable material
No thin gas-permeable material film; thick silicone gas-permeable material on outside of vessel	Thin polystyrene film as gas-permeable material
No tracheal spaces	Tracheal spaces
Did not work	Worked

184. Corning did not use the Multilayer Flask design because it believed the design was flawed and did not work. Corning's testing showed that the design of the flask, with gas-permeable material at one exterior end, meant that cells further from the oxygen source would not receive the same amount of oxygen as the cells closer to the oxygen source. This result was not surprising to Corning's scientists—a fundamental law of physics, Fick's law of diffusion, explains why the WW Multilayer Flask design did not work due to the gradient differential.

185. No one, including Wilson Wolf, has ever commercialized a cell culture device using the WW Multilayer Flask design. This is despite the fact that Wilson

represented to Corning in August 2004 that the WW Multilayer Flask "can be on the market in one year or less."

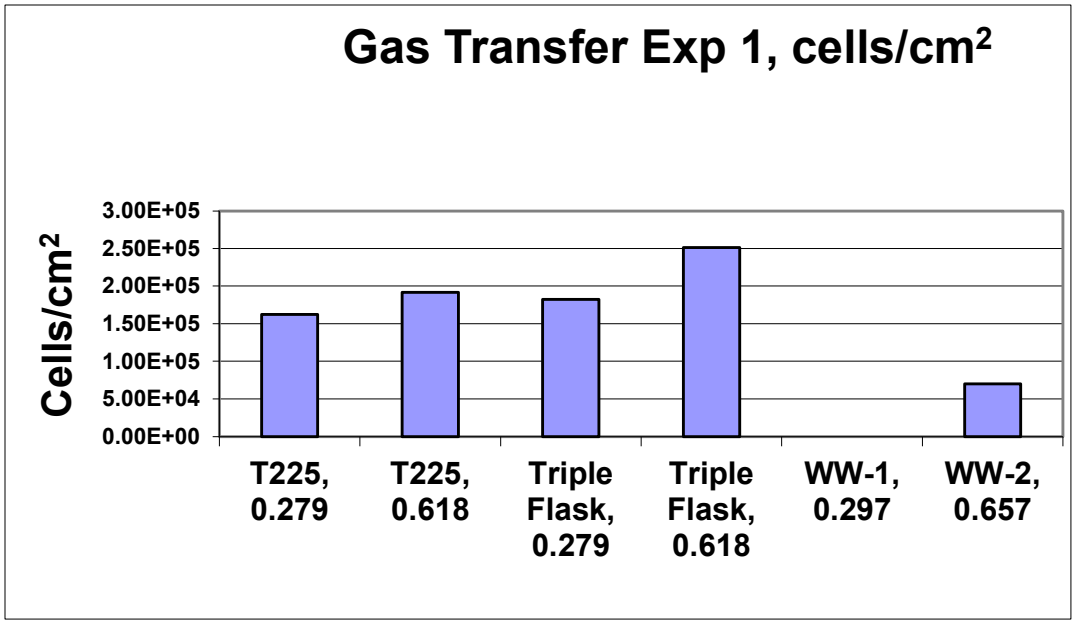
186. Wilson also presented the WW Multilayer Flask design to another major company, Becton Dickinson, in 2007 to compete with the HYPERFlask product. Becton Dickinson, like Corning, did not pursue the WW Multilayer Flask design because it concluded that Wilson's design would not work due to the design's inherent inability to uniformly oxygenate the cells.

187. Corning confirmed the design flaws in the WW Multilayer Flask through multiple rounds of testing. The WW Multilayer Flask failed all the tests.

188. Corning first tested the WW Multilayer Flask in July 2004, before the August meeting with Wilson.

189. Upton, who performed the testing for Corning, measured several different metrics. Cell yield—measured in cells per centimeter squared—was the performance metric of greatest interest to Corning.

190. Upton's data shows that the WW Multilayer Flask performed significantly worse than the control vessels in terms of total cell yield and cells per centimeter squared. The Wilson Wolf prototype cultured fewer cells than the Corning T-225 flask (the same design as the T-175, with a slightly larger growth surface area) and the Nunc Triple Flask. The graph below also visually shows that when controlling for growth surface area, the Wilson Wolf prototype cultured far fewer cells per square centimeter of growth surface area compared to the control flasks:



(DTX-10.)

191. In sum, the WW Multilayer Flask was able to grow about one-third as many cells per centimeter squared as the control vessels. The results for the WW Multilayer Flask did not meet Corning's commercial or scientific standards.

August 25, 2004 Meeting

192. Corning scheduled a second meeting with Wilson at Corning's facilities in Kennebunk, Maine. (PTX 36.)

193. Corning and Wilson then met on August 25, 2004.

194. On August 10, 2004, Wilson sent Beck and Kenton a 13-page document marked Confidential and that Wilson contends included an overview of products he was working on at Wilson Wolf. (PTX 31.) However, Corning demonstrated that this document does not provide any designs, proof of concept, or other specificity about Wilson's concepts.

195. This document was forwarded internally to Hoover and, later, to Jeffrey Mooney, the Commercial Technology Director at Corning. While the email was forwarded to Tanner, Upton, and Phillip Carey, there is no evidence that the document was attached or that any of those individuals reviewed it. (PTX 31, 47.)

196. On August 16, 2004, Sebastien Chauvel sent Upton a list of four Wilson Wolf patent applications.

197. Plaintiffs also provided Corning with a copy of the '651 provisional application, which was marked confidential.

198. Hoover asked Tanner to review the '651 provisional application in preparation for the August 2004 meeting.

199. The following people attended the August 25, 2004 meeting with Wilson: Tanner, Titus, Upton (Applications Scientist), Mooney (Commercial Technology Director), and Hoover (as Applications Manager). Kenton and Beck were in the meeting for introductions and then left to work on other business matters. This was the first time that Tanner met Wilson.

200. The agenda for the meeting included introductions, updates from John Wilson on product development and intellectual property, updates from Todd Upton on "Vertical Bag data review" and "Gas transfer fixture data," and an open discussion on "Product options for best alignment of Corning's and Wilson Wolf's." (PTX 36.)

201. At the beginning of the meeting, Mooney asked Wilson to remove prototypes that Wilson had placed on a table and to put them back into a bag because Mooney did not know whether they were covered by the CDA.

202. The evidence at trial demonstrated that Corning representatives knew that a CDA was in place before the meeting.

203. At the August 25, 2004 meeting, the parties discussed the Vertical Bag and WW Multilayer Flask/GTF. Wilson had the opportunity to present updates on product development, and Corning presented an update on the testing data. Specifically, Upton shared the results of the testing described above. Upton presented the test results in the form of a PowerPoint, but that 2004 PowerPoint was no longer available when Plaintiffs filed their Complaint in 2013.

204. Wilson acknowledges that "there was information provided" at the meeting that "the gas transfer was not performing well."

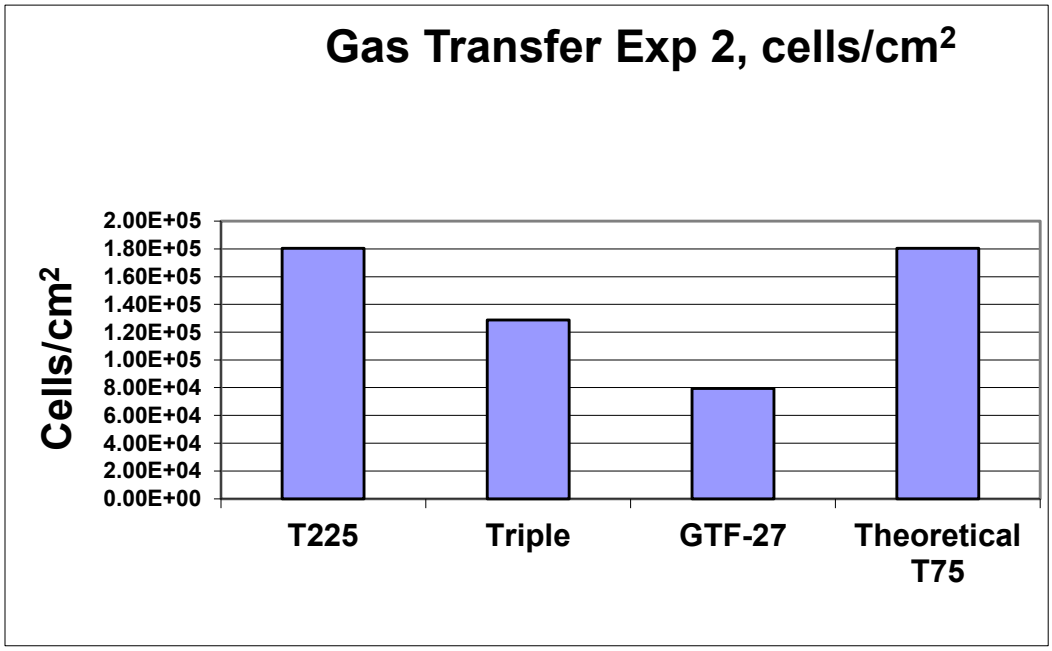
205. Because the prototypes did not work, Wilson sent Corning two more WW Multilayer Flask prototypes. Plaintiffs dispute that the prototypes did not work, but Wilson acknowledges that he sent more prototypes.

206. On September 13, 2004, Wilson sent Upton "two prototype multiple shelf flasks for your evaluation." In his cover letter, Wilson stated that Wilson Wolf's "evaluations indicate that the prototypes are about 80% confluent at the time of confluence is reached in control flasks." The objective in cell culturing is to grow cells to full confluence, which Wilson's prototypes could not achieve. Confluence is a measure of how well the adherent cells have covered the surface that they reside on, with 100% confluence being full coverage.

207. Wilson Wolf had performed its own testing and knew that, at the time it sent the additional prototypes to Corning, the prototypes did not perform as well as the T-175 control flask.

208. Corning tested the second set of WW Multilayer Flasks in December 2004—the second round of testing of Wilson's flask design. Upton again performed the testing and again measured several different metrics.

209. Upton's data shows that the WW Multilayer Flask, denoted as GTF-27, performed significantly worse than the control vessels in terms of total cell yield and cells per centimeter squared. The graph below visually shows that when controlling for growth surface area, the Wilson Wolf prototype cultured far fewer cells per square centimeter of growth surface area compared to the control flasks.



(DTX-11.)

210. The performance of the WW Multilayer Flask in the second round of testing was similar to the first: the WW Multilayer Flask performed worse than the control vessels, producing about one-third of the cells per centimeter squared as the T-225 flask and about one-half of the cells per centimeter squared as the Triple Flask. These results remained unacceptable to Corning.

211. At trial, Plaintiffs suggested that Upton should have used a different metric when testing the performance of the WW Multilayer Flask. Instead of calculating cells per centimeter squared, Plaintiffs claimed that Upton should have calculated cells per centimeter cubed, or the per unit volume. According to Plaintiffs, cells per centimeter cubed would measure how efficiently "space" was used to grow the cells.

212. Upton, however, explained that the WW Multilayer Flask was designed to culture adherent cells—which grow in a single layer on a growth surface—and therefore the proper measure is cells per centimeter squared, or the unit area. Calculating the cells per unit volume is "not how you evaluate adherent cell culture." That calculation is "irrelevant because you don't measure adherent cell performance by measuring the volume of the vessel it is in. You measure it by the surface area that it consumes because they are adhered to that surface area."

213. Importantly, at the time that Wilson was presenting his WW Multilayer Flask to Corning as a viable cell-culture device in 2004 and 2005, Wilson never told Corning to evaluate his device using this per unit volume metric. Nor did Wilson himself ever test and provide data to Corning using this per unit volume metric. The first time

that Wilson suggested that Corning should have evaluated his device on a cells-per-centimeter cubed basis was at trial.

214. The Court acknowledges the parties' differing opinions on the proper metrics to test but finds that Corning had no obligation under the CDA or otherwise to use a particular test or metric to determine the utility of the prototypes for Corning's purposes. Corning was testing the prototype to ascertain whether it would satisfy Corning's commercial needs.

December 2004 Meeting in Minnesota

215. Corning representatives traveled to New Brighton, Minnesota, to meet with Wilson on December 10, 2004. Tanner, Verkleeren (project manager for WW project), Joe Wall (mechanical design), and Phil Carey attended on behalf of Corning,.

216. Before this meeting, it was suggested internally at Corning that they ask Wilson if he has thoughts on a 10x yield device, but Tanner expressed concern about discussing a 10x yield device with Wilson because of the work she and Martin had put into their concepts and because they had not written invention disclosures for the concepts due to the complexity of the cell-culture intellectual property. (PTX 44.)

217. At this time, Wilson knew that his prototypes failed Corning's testing and that he needed to prove to Corning that his concept worked. Specifically, around December 16, 2004, Wilson recorded in his handwritten notebook that Upton's testing produced "less cell density than they have seen previously" and that "[f]easibility has not been established." Wilson noted that his "concept is unproven." (PTX-128.)

218. Additionally, Wilson's typed "correspondence trail" indicates that on approximately December 21, 2004, Corning told Wilson again that "they need proof the concept works (Todd's data is not convincing)." (PTX-34 at WW043329.)

219. Even though Wilson's prototypes failed two rounds of testing, Corning continued to work with Wilson to determine whether his WW Multilayer Flask could work.

220. Corning provided Wilson materials to construct his prototypes, surface treatments for his shelves, protocols for testing, cells for use in testing and information about materials to be used in testing, and more.

221. Wilson Wolf did not provide Corning a working prototype.

222. Wilson's correspondence with Corning during this period reflects Wilson's own awareness and recognition of his prototype failures. On February 14, 2005, Wilson emailed Upton and stated the "test device with 5 scaffolds" had far fewer cells than the control flask when there should "have been about 1.8 times the number of cells in the t-flask." (PTX-288.)

223. On February 15, 2005, Wilson sent Upton and Tanner a "picture [that] shows what the staining process rendered with a single scaffold test device that was about 80-90% confluent. The control flask was 100% confluent and stained perfectly." (DTX-166.) According to Tanner's testimony at trial, this showed that the WW Multilayer Flask did not work as well as the T-175 flask and that "this design was probably not going to work for moving forward." (11/21/22 Tr. 2575:22-25777:13.)

224. On February 23, 2005, Wilson told Tanner that he was "continuing to attempt to determine the cause of the lack of cell presence in the proto[types]." (DTX 167.) A few days later, on February 28, 2005, he told Tanner that he was resorting to making new prototypes and that he was sending her "the reworked proto[types]." (DTX 170.)

225. Having failed to produce a prototype that worked, Wilson tried to change the standards for the testing. In late-February 2005, Wilson reported results from his own tests that were performed under modified conditions that were more favorable for his prototype and bettered his chances of obtaining successful test results.

226. Corning informed Wilson that he should perform testing pursuant to the original, agreed-upon protocol. Wilson did not do so.

227. In early March 2005, Corning decided not to do further testing or work with the Wilson Wolf prototypes. Between March 11 and March 18, 2005, Tanner called Wilson and told him that Corning would not be testing his prototypes further.

228. Wilson nonetheless sent Corning test results on March 21, 2005, that showed glucose-lactate ratios for his prototypes. Corning did not request this data. The data was not helpful or relevant because it did not provide any information about the number of cells grown—which, as Wilson knew, was the metric Corning was evaluating.

229. Wilson complained that Corning had "digressed from [the] vision" of revolutionizing cell culture to "arguing about the small details of the design of one device out of a potentially huge product array." He was upset that Corning was focused on "the value of gas permeable walls on one style of prototype in one experimental condition"

(which did not work), when Wilson was instead focused on his "vision" of Corning manufacturing and distributing all of his product designs. (PTX-34 at WW043314.)

230. Wilson did not provide Corning with any testing data that demonstrated his WW Multilayer flask worked.

231. Wilson acknowledged that he had "trouble getting the kind of information that Corning wanted" to prove his concept worked.

232. And later, in 2007 during a meeting with Corning representatives that Wilson secretly recorded (discussed below), Wilson admitted to them that to call the testing results of his WW Multilayer Flask "inconclusive" was a "fair, intellectually honest statement."

233. Thus, Wilson acknowledged and admitted that he was unable to demonstrate the WW Multilayer Flask design was or could be a successful design.

Cont'd-Alleged Items Shared Under the CDA

(Additional Designs)

234. The third item that Wilson shared with Corning consisted of additional cell-culture design concepts, besides the Vertical Bag and the WW Multilayer Flask. These other designs included a device Wilson called a "membrane-based roller bottle," a "gas permeable deep well plate," a "high density multiple well plate," and a "high density roller bottle."

235. The evidence establishes that Corning was not interested in and did not use any of these designs.

('651 provisional application and the '814 application)

236. The fourth item that Wilson provided to Corning was two related and then-confidential patent applications: first, his '651 provisional application, which he had already filed with the U.S. Patent & Trademark Office, and later, his '814 utility application. Both applications were marked "confidential" under the CDA.

237. The '651 provisional application discloses the Wilson Wolf Multilayer Flask design. The '814 application claims priority to the '651 provisional application and similarly claims a gas-permeable cell-culture device wherein the bottom comprises a gas permeable material and at least a portion of the side is comprised of a gas permeable material. (PTX 6.)

238. Wilson sent a copy of the '651 provisional application to Hoover in August 2004, in advance of the August 25, 2004 meeting at Corning. Hoover asked Tanner to review the application, which she did before she attended the meeting.

239. Plaintiffs assert that the '651 provisional application contains trade secrets, including "ideas for combining" certain features into a cell-culture device, such as: (1) how to use gas-permeable materials to eliminate the need to oxygenate cells through a gas-liquid interface, without the need to spin, shake, roll, or stir the device; (2) a valuable IP landscape and the patentability of Plaintiffs' technology over the prior art; (3) a wide variety of combinations of attributes, including the combination of the following "key features":

A. A static device for animal cell culture that is not compartmentalized by a semi-permeable membrane that includes gas permeable liquid impermeable

material in a location where it will be in contact with media that is in contact with media during the cell culture process, and at least a portion of the gas permeable material that is in contact with media during the cell culture process is also in contact with ambient gas;

B. The device can function when it is filled with media and absent a gas/liquid interface;

C. During use, the device is capable of holding media in a location where the uppermost location of the media is at a height beyond 2.0 centimeters from the lowermost location of the media;

D. During use, the device can hold media in an area not directly above the growth surface;

E. The device includes a growth surface that is gas permeable and in contact with ambient gas;

F. [No feature F.]

G. The device includes growth surfaces that are arranged in vertical succession;

H. [No feature H.]

I. The device includes a manifold;

J. The device includes gas permeable material in support in contact with gas permeable growth surface;

K. The device geometry allows media to reside directly above each growth surface that is arranged in vertical succession at a height of 2 millimeters to 3 millimeters.

240. After the August 25, 2004 meeting with Wilson, Tanner prepared a summary of the information that Wilson shared at the meeting, which included the '651 provisional application.

241. Tanner summarized the takeaway from the '651 provisional patent application as follows: "suggests that using gas permeable material (specifically claims silicone) in the construction (bottom and/or sides) of petri dishes, multiwell plates, flasks, multi-layer flasks, roller bottles, culture bags, and cell stacks. Patent application allows for medium height to be greater than in other gas permeable cell culture devices." (PTX 276.)

242. Thus, what Corning asserts it took from the patent applications and Wilson's descriptions of them was that there were three aspects to the claimed invention: (1) the use of silicone as a gas-permeable material; (2) a gas-permeable material located on the bottom or the side of the device; and (3) media height greater than in existing cell culture devices.

243. The Court specifically finds that Corning did not use any of those features in its HYPERFlask or HYPERStack products.

244. At an internal brainstorming meeting on September 1, 2004, Tanner shared her Wilson Wolf product summary, but did not disclose any more information regarding the Wilson Wolf product concepts or Wilson's '651 provisional application beyond what

was described in the written summary. The Court finds Tanner's testimony on this point credible.

245. The '651 provisional application does not disclose Corning's tracheal-flask design.

246. Martin's and Tanner's previously conceived tracheal design is different in several significant ways from the designs in the '651 provisional application. The '651 provisional application's disclosure of gas-permeable material on the bottom or sides of a vessel taught the use of gas-permeable material on the *exterior* of the device. This was different than Martin's and Tanner's tracheal-flask design, which used gas-permeable material on the *interior* of the device.

247. In addition, silicone was not a gas-permeable material that Tanner and Martin were interested in for their design for the TAP project because they "were looking for a material that cells would adhere to, and cells don't adhere well to silicone."[5]

248. The greater media height disclosed in the '651 provisional application also was not of any interest to Tanner for the TAP project because "adding extra media would decrease the efficiency of the vessel" and they would "have to increase the size of the vessel in order to accommodate it." (11/21/22 Tr. 2516:20-2517:10.) This was contrary to what Tanner and Martin were trying to achieve with their tracheal-flask design. (*Id.*)

[5] Even if the disclosures are not limited to using silicone, the evidence does not support a finding that Corning used any confidential information.

249. Wilson acknowledged that the ’651 provisional application did not disclose the technology of using gas-permeable shelves with air spaces between them. The HYPER products’ tracheal space is a key feature, which Wilson later admitted was “pretty powerful.”

250. Wilson also acknowledged that the ’651 provisional application did not teach or disclose the complete configuration of the HYPER products.

251. In this litigation, rather than assert that Corning used the devices actually disclosed in the ’651 provisional and ’814 patent applications, Plaintiffs argued that the patent applications disclosed nine “insights” or “trade secret elements” that could be combined into various combinations, which they assert Corning used.

252. However, Wilson acknowledged that every alleged “trade secret element” was known in the prior art and that he was not the first to come up with any individual element.

253. The Court finds that none of the alleged “trade secret elements” are in fact Wilson Wolf’s trade secrets or Confidential Information.

254. Wilson was not the first to use a gas-permeable membrane to form a culture chamber in which to culture cells; Wilson was not the first to come up with a concept of static cell-culture devices that are gas permeable and oxygenate the cells by way of gas transfer through the device housing; and Wilson was not the first to come up with the idea of a multi-shelf device.

255. The Court also finds that Wilson did not establish that the ’651 provisional application discloses any of the alleged combinations of “trade secret elements.”

256. Plaintiffs did not demonstrate that the alleged combinations constituting trade secrets are disclosed in the '651 provisional application.

257. Plaintiffs did not offer testimony or other evidence that the alleged trade secret combinations had independent economic value by virtue of being secret. Plaintiffs provided only general testimony that "trade secrets" in Wilson's patent applications had economic value when the applications were filed. Wilson did not address the specific combinations that Plaintiffs alleged were their trade secret or explain why any combination had economic value by virtue of being secret.

258. Eric Simon, Corning's expert in the field of cell-culture product design addressed Plaintiffs' alleged trade secret combinations. Simon testified that the combinations did not have "economic value." (12/01/2022 Tr. 3884:6-12.) Simon further testified that to have value in the field of cell-culture design, an alleged trade secret needed to reflect a specific design and not a combination of elements that could be met by any number of different (undescribed) designs. (11/30/2022 Tr. 3732:22-3740:25.) Simon explained that Wilson Wolf's alleged trade secret combinations are "simply targets, loose endpoints that you're striving to meet," which do not have value to a designer of a cell culture vessel. (12/01/2022 Tr. 3884:6-12.) Plaintiffs did not offer testimony rebutting Simon's views. The Court finds Simon's testimony credible and admissible.

259. In addition, the Court finds that the evidence at trial shows that Corning did not use any information from the '651 provisional application or the '814 application in the development of the HYPERFlask and HYPERStack products. The evidence at trial

demonstrates that Martin and Tanner conceived of the tracheal-flask design before Corning's receipt of Wilson's patent applications and the tracheal-flask design was different than the designs disclosed in those applications.

(SBIR application)

260. The fifth and final item that Wilson claims he showed Corning is the SBIR grant application, titled "Islet culture, shipping, and infusion device." The SBIR application describes two devices, both for use with islet cells: (1) the application's "Primary Device" which is a single-layer device ("SLD") using a gas-permeable membrane; and (2) the application's "backup" device, a Multi Level High O_2 Device ("MLD"). Plaintiffs have alleged in this litigation that the MLD contains design features that Corning used.

261. Islet cells are within the pancreas and help to control blood sugar.

262. Wilson Wolf built and tested the SLD, which showed good results, and thus Wilson Wolf pursued the SLD.

263. Wilson Wolf never developed, built, or tested the MLD. Wilson Wolf did not make or develop a prototype of the MLD.

264. The provisional patent application that attached portions of the SBIR application as an exhibit, and thus contained the MLD device, was not filed until 2006, which postdates Wilson's interactions with Corning concerning flask design.

265. Plaintiffs contend that they conceived of the device in Figure 6 of the SBIR grant application before meeting with Corning, and that the '651 provisional application disclosed the trade secret combinations used in Figure 6 of the SBIR application.

266. However, Wilson testified that the SBIR grant application was never given to Corning.

267. There is no evidence that any document that contained the substance of the SBIR application was given or shown to Corning.

268. Wilson contends that Plaintiffs confidentially disclosed the existence and basic features of the islet device and SBIR grant to Corning in connection with the August 25, 2004 meeting with Corning.

269. However, Wilson Wolf offered no documentary evidence that the SBIR application designs were disclosed to Corning.

270. Any disclosure of Wilson Wolf's receipt of grants to develop an islet device is not a disclosure of the device's design itself. None of Wilson Wolf's disclosures of grants for work on an islet device gave any indication of the device's design, nor did they indicate whether the generally referenced islet device was the MLD as opposed to the SLD.

271. There is no documentary evidence that the SBIR application's MLD design was ever provided to Corning.

272. There were three in-person meetings between Corning and Wilson. The SBIR application's MLD design was not provided to Corning at any of those meetings.

273. Plaintiffs do not claim to have provided the SBIR application's MLD design to Corning during the March 2004 meeting between Corning and Wilson Wolf in New Brighton, Minnesota.

274. Similarly, the SBIR design was not shown to Corning during the next meeting between Corning and Wilson Wolf in Kennebunk, Maine, on August 25, 2004. Corning witnesses testified that they did not receive or see the SBIR design during this August 2004 meeting. Titus testified that she would remember if the topic arose because it was almost a year to the day after her daughter was diagnosed with diabetes, for which islet cells have been explored as a possible treatment. The Court finds the Corning witnesses testimony to be credible.

275. Contemporaneous evidence corroborates the Corning witness testimony. Documents provided to Corning by Wilson summarizing the products that he discussed at the meeting do not include the SBIR MLD design. Tanner's summary of Wilson Wolf's products after the August meeting referenced an islet device but stated that the "device [was] unclear" and provided no design information.

276. Further, the SBIR application's MLD design was not provided to Corning at the meeting between Corning and Wilson Wolf in December 2004. Wilson testified that he did not recall the details of what was disclosed at the meeting. Tanner, who attended the meeting, testified that Wilson did not show Corning any SBIR grant application during the meeting. The only comments that Wilson made at the December 2004 meeting regarding SBIR applications related to the amount of grant funding Wilson Wolf received. Ron Verkleeren, Corning's Business Development Manager, was also at the December 2004 meeting with Wilson Wolf and confirmed this—Wilson never showed Corning any SBIR grant application or any device designs from an SBIR grant application. Instead, the evidence shows that Wilson spoke about the grant funding that

Wilson Wolf was able to secure from the SBIR, but that he did not provide details of the designs therein.

277. Documents contemporaneous to the December 10, 2004 meeting support Corning testimony that the SBIR application was not provided, shown, or disclosed at the meeting.

278. The only evidence that Plaintiffs disclosed the SBIR application's MLD design is the testimony of Wilson's long-time employee, Dan Welch. Welch believed that Wilson had shown a copy of the SBIR design on a computer screen, which was in the corner of the room. But Welch stated that he did not keep any contemporaneous notes of what he saw on that day. Welch had no recollection of the specific details of any discussions at this meeting, including anything that Wilson said to Corning.

279. Tanner testified that, while a design was shown on Wilson's computer as Welch testified, it was a different design than the SBIR's MLD. The contemporaneous documents support this. Corning's notes recapping the meeting describe a "design . . . of a collection of square plates within a gas permeable housing," with "[t]wo ports in the top [that] would allow access for medium and air equilibration," "[n]eedle insertion into the port [that] would allow medium to be vacuumed through a check valve that would close when full," and with "[f]resh needles revolving on a disk [that] would be available for each cell culture vessel." (DTX 196.) Welch testified that, at the time, Wilson Wolf had a prototype like the one Tanner described in her contemporaneous notes. (11/16/22 Tr. 1749:13-17501). This was not the SBIR application's MLD device.

280. In addition, the SBIR application's MLD design is different from Corning's HYPER products. The MLD had cell-culture compartments made of silicone rubber, with a manifold that could collapse and seal the access opening of each compartment. This was important to the design because the intended primary use of the MLD was not to culture cells (like the HYPER products) but to transport and deliver islet cells. The MLD was to be constructed almost entirely out of silicone rubber, including the shelves and the outer housing. There were some shelf supports to help keep the silicone chambers separated, but there was otherwise no rigidity to the device. The MLD essentially was a silicone bag with shelves. When filled with liquid media, the MLD would resemble a water balloon.

V. Corning's HYPER Products Differ from Plaintiffs' Designs

281. As noted above, the design of Corning's HYPER products is fundamentally different with respect to key features from any design that Plaintiffs shared with Corning. These differences further support the Court's finding that Corning did not use any of Plaintiffs' Confidential Information or trade secrets.

282. All of Plaintiffs' alleged Confidential Information—the product concepts and the '651 provisional application—were allegedly disclosed or discussed at the August 25, 2004 meeting, with the exception of the SBIR application, which, as discussed above, was never disclosed to Corning.

283. After the August 25, 2004 meeting with Wilson, Tanner prepared a summary of the information that Wilson shared at the meeting.

284. For every product concept that Wilson allegedly shared, the device used gas-permeable material on the exterior of the device, on either the side or the bottom. The ’651 provisional application similarly disclosed the use of gas-permeable material (claiming silicone, specifically) in the “bottom and/or sides” of the cell culture device.

285. In contrast, the HYPER Products use a gas-permeable material on the interior of the device, as the cell growth surface.

286. In addition, the HYPER products are also significantly different from the prototypes that Wilson provided to Corning: the Vertical bag and the WW Multilayer Flask.

287. As noted above, the Vertical Bag device differs from the HYPERFlask device with respect to many key features.

288. Also noted above, the HYPERFlask and HYPERStack products differ in several key ways from the WW Multilayer Flask.

289. The differences between Corning’s HYPER products, Plaintiffs’ product concepts, prototypes, Confidential Information, and trade secrets further establish that Corning did not use any of Plaintiffs’ information in the development of the HYPER products.

VI. Wilson’s Inventorship Claims

290. Wilson claims to be the sole inventor of Corning’s ’209 Patent and a joint inventor of both Corning’s ’572 and ’345 Patents.

291. On May 11, 2006, Corning filed Application No. 11/433,859. (PTX 240.)

292. The ’859 Application issued as U.S. Patent No. 7,745,209 on June 29, 2010. (*Id.*)

293. The named inventors of the ’896 provisional application, the ’859 application, and the ’209 Patent are Gregory R. Martin and Allison J. Tanner.

294. Wilson is not a named inventor of the ’896 provisional application, the ’859 application, or the ’209 Patent.

295. On May 19, 2010, Corning filed Application No. 12/783,217, which issued as U.S. Patent No. 8,273,572 (the “’572 Patent”) on September 25, 2012. (PTX 304.)

296. The ’209 Patent and the ’572 Patent share the same specification.

297. The named inventors of the ’217 Application and ’572 Patent are Gregory R. Martin and Allison J. Tanner.

298. Wilson is not named as an inventor on the ’217 Application or the ’572 Patent.

299. On September 16, 2008, Corning filed Application No. 12/211,378 (the “’378 application”). (PTX 118.)

300. The ’378 Application issued as U.S. Patent No. 8,178,345 (the “’345 Patent”) on May 15, 2012.

301. The named inventors of the ’378 application and the ’345 Patent are Gregory R. Martin, Allison J. Tanner, Scott M. Bennett, Henry J. Cattadoris, David A. Kenney, and Joseph C. Wall.

302. Wilson is not named as an inventor on the ’378 application or the ’345 Patent.

303. Wilson's evidence in support of his joint and sole inventorship claims consists of his testimony, his interpretation of the '651 provisional application and related prototypes, and his application of his various interpretations of his own work to the claims of the Corning patents. No expert or other evidence corroborated Wilson's opinions.

304. As noted above, Tanner and Martin (and other Corning employees named as inventors on the '345 Patent) conceived of every element of the '209, '572 and '345 Patents without any assistance or contribution of an inventive concept by Wilson. Titus's testimony and the other evidence presented by Corning at trial supported and corroborated Martin's and Tanner's testimony that they (and other Corning employees named as inventors on the '345 Patent) conceived of every element of the '209, '572, and '345 Patents without any assistance or contribution of an inventive concept by Wilson. Because Tanner and Martin independently conceived of every element of the '209, '572, and '345 Patents (along with other Corning employees named as inventors), Wilson is not and cannot be a sole or joint inventor of the patents.

305. Further, Simon, Corning's expert witness, testified that Wilson's concepts were fundamentally different from the claimed inventions of the '209, '572, and '345 Patents, and that Wilson made no contribution to the '209, '572, and '345 Patents' claims.

306. Wilson testified that his inventive contributions to the '209, '572, and '345 Patents that he communicated to Corning were contained solely in the '651 provisional application.

307. Although Wilson testified that he communicated every inventive feature of his '651 provisional and '814 applications to Tanner at the August and December 2004 meetings, the Court finds that this testimony is neither credible nor sufficient based on the entire record before the Court. Those meeting were attended by other individuals and had lengthy agendas. There is no evidence that Wilson had any private, one-on-one conversations with Tanner during these meetings, and no contemporaneous documents support Wilson's testimony that he verbally communicated information related to his '651 provisional and '814 applications to Tanner.

308. In addition, the '814 application, which claims priority to the '651 provisional application, was published as U.S. Patent Application Publication No. 2005/0106717 on May 19, 2005 (the "'717 publication). (DTX-187.) And the '814 application had previously published on April 21, 2005, when a related foreign patent application published. (DTX-182.) Based on this record, all alleged inventive concepts in Wilson's '651 provisional application became public (and part of the prior art) when the '814 application published on April 21, 2005.

309. The Patent and Trademark Office also considered Wilson's '651 provisional application when it issued the '209 and '572 Patents. The '717 publication was expressly identified as a cited reference by the patent examiner on the face of the '209 and '572 Patents. The patent examiner therefore recognized that the '209 and '572 Patents were novel and different than the devices disclosed in the '651 provisional application.

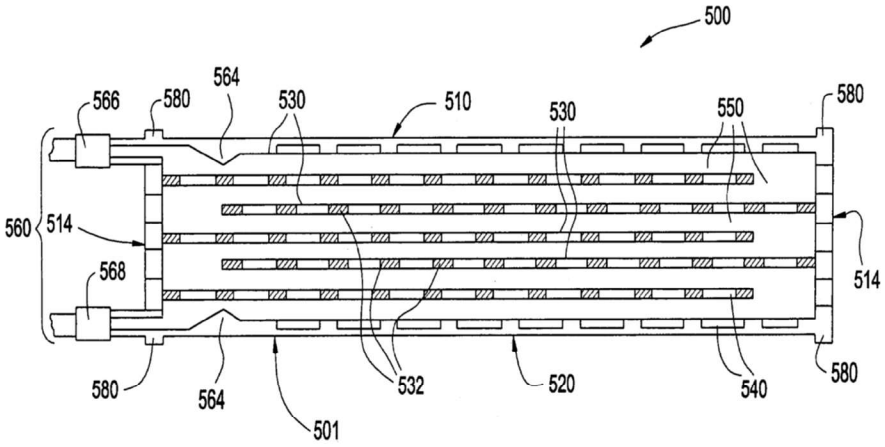
310. Wilson's inventorship claims fail for several additional reasons.

311. With respect to Corning's '209 Patent, for which Wilson claims sole inventorship, Wilson admitted that he did not invent each and every element of every claim, as would be necessary to show sole inventorship.

312. The '209 Patent includes a "perfusion embodiment" in its Figure 5 embodiment—which is an embodiment that permits the "continuous flow" of liquid nutrient medium through the device. The patent describes and claims in its independent claims a device that is capable of being used with the medium either stationary ("static") or continuously flowing (a form of "perfusing"). The '209 Patent also has several narrower dependent claims that require media to "continuous[ly] flow" through the device.

313. For example, Figure 5 of the '209 Patent illustrates "another embodiment of the present invention" and depicts a "partial internal . . . cross-sectional view[] . . . a multilayered culture vessel of the present invention is a perfusion system."

FIG. 5



(PTX-116 ’209 Patent at col. 9, ll. 7-10 & Fig. 5.)

314. Wilson concedes that he did not invent the perfusion concept in the ’209 Patent. (11/15/22 Tr. 1443:19-1444:3; 1460:5-8.)

315. Martin, a named inventor on the ’209 Patent, conceived of the perfusion embodiment claimed in the ’209 Patent, with no assistance from or contribution by Wilson. Figure 5 of the ’209 Patent is the identical drawing that Martin drew no later than September 8, 2004, in a PowerPoint which was combined with other files and emailed to Titus on September 9, 2004.

316. Plaintiffs have not presented evidence to establish that Wilson had had any contact with Martin or that Martin received or reviewed any of Wilson's patent application(s), prototypes, or designs before Martin originated the Figure 5 embodiment. In fact, Martin testified that, before the lawsuit, he had never met with Wilson, had a one-on-one conversation with him, or received any correspondence from him in any form. Martin also testified that he had conceived of the Figure 5 embodiment and a "tracheal" design before seeing any of Wilson's designs. This testimony is unrebutted and consistent with and supported by the testimony of multiple other witnesses, including Tanner, Titus, Hoover, and Upton, as well as the documentary evidence.

317. Simon's expert testimony further supports Martin's testimony that the Figure 5 embodiment originated solely with Martin without any involvement or contribution by Wilson. Simon testified that the Figure 5 embodiment is fundamentally different from the designs presented by Wilson and cannot be derived from those designs.

318. In addition, Wilson did not present evidence—other than his uncorroborated opinions—that he contributed numerous other inventive elements of the '209 patent, including a plurality of cell-growth chambers, each cell-growth chamber having a gas-permeable material, or tracheal spaces. Again, Martin and Tanner conceived of these elements before any contact with Wilson. And, further, none of these elements are found in Wilson's '651 provisional application.

319. Wilson also failed to establish that he made an inventive contribution to Corning's '572 or '345 Patents—for which he seeks a declaration of joint inventorship.

Wilson's alleged contributions to the '572 and '345 Patents are also contained solely in his '651 provisional application.

320. The Figure 5 embodiment of the '209 Patent is also part of the '572 Patent. Unrebutted testimony from both Martin and Simon confirmed that the Figure 5 embodiment is covered by each claim of the '572 Patent. (11/17/2022 Tr. 2027:3-2031:21; 11/30/2022 Tr. 3839:5-3854:7). As noted above, Wilson made no contribution to the Figure 5 embodiment.

321. Wilson also failed to demonstrate that he made any other contribution to the claims of the '572 Patent. Again, Martin and Tanner conceived of every element of the '572 Patent without Wilson's assistance or contribution to an inventive concept. Titus's testimony, Simon's expert testimony, and the other evidence presented by Corning supported and corroborated Martin's and Tanner's testimony on this point. (11/30/2022 Tr. 3839:5-3854:7.)

322. Wilson also failed to establish that he made an inventive contribution to the '345 Patent. The application that led to the '345 Patent was filed on May 30, 2008, approximately three years after Wilson's last interactions with Corning with respect to his prototypes and any technical disclosures related to them. The filing of the application that led to the '345 Patent was also more than three years after Wilson's '651 provisional and '814 applications published.

323. The Court finds that the inventive concept of the '345 Patent concerned new and additional work the inventors did after the time of the '209 and '572 Patents that led to the new invention that is the '345 Patent. The '345 Patent names a different set of

inventors from the ’209 and ’572 Patents. The claimed improvement of the ’345 Patent is a cell-culture device in which each “flaskette” has an internal “boss” that engages with the boss of the next flaskette, a cavity in each boss, and a unitary column that runs through the bosses.

324. This improvement is found nowhere in any of Wilson’s disclosures to Corning. Wilson did not produce any evidence that he contributed to the ideas in this patent. Wilson did not make or participate in the creation of any drawings in the ’345 Patent. Indeed, the concept that made the ’345 patent inventive dates to a later period when Corning was no longer communicating with Wilson, and it involves other Corning inventors who had no interaction with his ideas.

325. Wilson’s sole evidence of his alleged contributions to the ’345 Patent consisted of disclosures in the ’651 provisional and ’814 applications. Again, the ’651 and ’814 applications became public no later than May 19, 2005, when the USPTO published the ’717 publication. The pre-America Invents Act version of 35 U.S.C. § 102(b) bars Wilson from seeking patent coverage based on the contents of those patents one year after the date of their publication.

326. Here, the statutory bar went into effect no later than May 19, 2006, as to the ’651 provisional and ’814 applications. The provisional application that produced Corning’s ’345 Patent was filed more than a year later, however, on May 30, 2008. The application that actually issued as the ’345 Patent was not filed until September 16, 2008. Wilson is barred by 35 U.S.C. § 102(b) from using the disclosure in the ’651 provisional and ’814 applications to seek to be added as a co-inventor on the ’345 Patent.

327. In addition, there is no evidence that Wilson alone conceived of every element of the '209 Patent such that he is not the sole inventor. Nor is there any evidence that Wilson contributed any inventive concept to the '572 or '345 Patents such that he is a joint inventor of those patents. The evidence presented at trial establishes that Tanner and Martin conceived of every element of the '209 and '572 Patents, and with other Corning employees named as inventors, every element of the '345 Patent.

VII. Plaintiffs' Delay

328. All events relevant to Plaintiffs' claims in this case occurred before June 2005. Plaintiffs filed this lawsuit in 2013. Plaintiffs' delay in bringing this lawsuit was unreasonable and lacks good cause.

329. In 2005, nearly eight years before Plaintiffs filed their Complaint, Wilson knew all the facts he relies on to claim that Corning had misappropriated Wilson Wolf's trade secrets.

330. Wilson's own handwritten notebook and typewritten "correspondence trail" contain statements demonstrating that he had knowledge of these facts as early as April 2005.

331. On April 4, 2005, Wilson had a telephone conversation with Tanner, who Wilson described as "curt and adamant that [the Wilson Wolf] device showed no value." Wilson "argued" with Tanner about the testing and devices, but Tanner "kept stating the tests failed because the gas permeable test fixture did not outperform the gas permeable control." Wilson concluded: "Something's wrong here." (PTX 34.)

332. On April 5, 2005, Corning's Verkleeren told Wilson that the WW Multilayer Flask "ha[d] no value because cells were cultured in the absence of a gas/liquid interface without a gas membrane." Wilson claimed at the time that "it is Wilson Wolf that showed [Corning] that cells can be cultured in the absence of a gas/liquid interface." Wilson had another "heated conversation" with Verkleeren two days later on April 7, 2005. (PTX 34.)

333. A week later, on April 15, 2005, Wilson and Welch had a phone call with Tanner and Verkleeren. In that call, Wilson "directly questioned them about ownership." According to Wilson, Tanner and Verkleeren "did not give [a] clear answer" in response and Verkleeren was "evasive and parsing words." (PTX 34.)

334. Corning's contemporaneous notes of the phone call similarly reflect that Wilson "seem[ed] to feel ownership for the idea that you can put multiple layers in a flask with no headspace." (PTX 271.)

335. On April 19, 2005, Wilson had a conversation with Walsh in which he expressly told her that Wilson Wolf was "asserting ownership of the non gas permeable as a trade secret[]." (PTX 34 at WW043313.)

336. On April 21, 2005, within days of these conversations with Corning in which Wilson asserted ownership over trade secrets and felt that "something's wrong," Wilson contacted an attorney "seeking legal advice regarding Confidentiality Agreement." (DTX 297.)

337. As of April 2005, Plaintiffs also had knowledge of facts they now claim show that Corning had breached the parties' CDA.

338. In 2007, two years after having consulted with an attorney about the CDA, Wilson took a number of actions that demonstrate that he had knowledge of the facts on which he bases his breach-of-contract claim against Corning.

339. On April 9, 2007, Wilson called Verkleeren with a "concern" about "Allison Tanner['s] patent application." Wilson told Verkleeren that he "believe[d] [Corning] ha[d] misappropriated confidential info." (PTX 34 at 43310-11.)

340. That same day, on April 9, 2007, Wilson called another Corning employee, Pierce Baker, and left a message about his "confidentiality agreement concerns." (*Id*. at 43311.)

341. Shortly thereafter, in April 2007 and continuing throughout 2007, Wilson had numerous communications with attorneys regarding "patent strategy in anticipation of litigation," "anticipation of patent interference proceeding," "legal advice regarding patent claims," and "legal advice regarding patent application."

342. In April 2007, Wilson Wolf ordered HYPERFlask vessels from Corning. Wilson and Wilson Wolf were therefore fully aware of the design and features of the HYPERFlask vessel by April 2007.

343. On June 14, 2007, Wilson retained the law firm of Oblon, Spivak, McClelland, Maier & Neustadt, P.C., regarding "Wilson Wolf Mfg. v. Corning Life Science." (PTX 441.)

344. Two months later, on August 21, 2007, Corning employees, including an in-house attorney, Thomas Beall, visited Wilson at Wilson Wolf's office in Minnesota. Wilson secretly recorded the meeting—including portions of the meeting in which

Wilson left the room and the Corning employees had private, attorney-client privileged communications. During this meeting with Corning, Wilson raised concerns about patent interference, potential breach of the CDA, and misappropriation—the same claims he brought in this 2013 lawsuit.

345. After the in-person meeting at Wilson Wolf, Wilson had a call with Rob D'Amore on August 29, 2007. Wilson's notes indicate that he wanted "to focus on a plan to cover all issues," including "infringement," "interference," and the "potential NDA."

346. Less than two years later, on May 6, 2009, Wilson called Beck, who was Corning's head of Business Operations. Wilson's handwritten notes reflect that one of Wilson's objectives for the call was to "point out [to Corning] that risk is present." (PTX 126.) According to Wilson's notes, Beck's "response focused on his belief they didn't do anything improper." (*Id.*) These notes demonstrate again that Wilson was aware of a potential dispute and threatening Corning with the "risk" of such a legal dispute. Wilson even testified that this was a communication about his dispute with Corning.

347. In May 2010, Wilson told a third party, Thermo Fisher, that Wilson Wolf's "patent portfolio has now placed Corning HYPERFlask in an infringing situation."

348. In September 2010, Wilson wrote in his notebook, "Shore up patent positions and delay battle with Corning."

349. In December 2010, Wilson again wrote in his handwritten notebook, "CORNING BATTLE. DELAY AS LONG AS POSSIBLE." (PTX-126.)

350. Plaintiffs did not file their Complaint against Corning until January 2013, eight years after Wilson initially had concerns about potential breaches of the CDA and the misappropriation of trade secrets.

351. There was no evidence presented at trial that Corning fraudulently concealed the alleged breaches or misappropriation from Plaintiffs. In fact, Corning's development and sale of the products was publicly known and known to Wilson.

352. Martin and Tanner sought patent protection for their tracheal-flask design, filing their '896 provisional patent application on July 26, 2005.

353. In September 2006, Corning publicly launched and began marketing the HYPERFlask product.

354. In December 2006, Corning continued to market and display its HYPERFlask product at the same trade show where it had met Wilson in 2003.

355. On February 1, 2007, Martin and Tanner's patent application for what became the '209 patent was published.

356. In early 2007, Wilson ordered HYPERFlask vessels which were shipped to Wilson Wolf.

357. Plaintiffs' unreasonable delay without good cause in filing this lawsuit also resulted in both economic and evidentiary prejudice to Corning in this case.

358. On the economic side, Corning made extensive financial investments in both the HYPERStack and HYPERFlask product lines. Corning invested $71 million in research and facilities for both products—including $66.4 million for the HYPERStack

product from 2010 to 2021 and $4.5 million for the HYPERFlask product from 2005 to 2009.

359. By 2021, Corning had spent an additional $47,058,465 on the HYPER products.

360. Corning invested millions of dollars in the HYPER products since the time that Plaintiffs could have brought their suit in 2005.

361. Corning also suffered evidentiary prejudice.

362. During the trial, Wilson admitted that he taped conversations between himself and Corning.

363. Wilson admitted that he taped conversations with Corning in hopes of obtaining a "smoking gun."

364. Wilson also admitted that he "scrapped" or deleted almost every recording when his tapes did not capture a "smoking gun." (11/10/2022 Tr. 905:1-908:23.)

365. Wilson further acknowledged that the tapes had no "smoking gun" supporting Plaintiffs' case. Had Wilson not delayed in bringing this lawsuit, these tapes may have still existed and could have been beneficial to Corning's presentation of evidence.

366. The only tape that does exist, from the August 21, 2007 in-person meeting, supports Corning's case.

367. The tape recording shows that Wilson and several Corning employees discussed the results of the prototype testing conducted by Corning.

368. At that meeting, Wilson told Corning that it would be a "fair, intellectually honest" statement to say that tests of his prototypes were inconclusive at the time that Corning tested his prototypes.

369. Wilson also told Corning that one of the HYPERFlask vessel's key features, "a tracheal space in between two gas permeable cell culture chambers" was "pretty powerful."

370. The delay also caused a loss of documentary evidence that prejudiced Corning.

371. Plaintiffs did not produce any Wilson Wolf emails from the critical 2004-to-2005 timeframe in this litigation. No emails were presented because they no longer existed. Internal Wilson Wolf emails would likely have provided information concerning Wilson Wolf and likely would have been available had the case been brought earlier.

372. By the time Plaintiffs filed this action in 2013, Corning had lost some documents and electronic files due to ordinary document retention policies that Corning otherwise would have retained and could have used to support its defense—emails, Martin's original "napkin" sketch of the tracheal flask design, other hand-drawn sketches, the electronic version of the September 9, 2004 email to Titus and electronic PowerPoint attachment, and additional metadata for the PowerPoint drawings.

373. Similarly, a central theme of Plaintiffs' case at trial was that Upton did not share testing information with Wilson. Wilson testified that Upton did not disclose the data from his tests. Upton, however, testified that this was false and that he *did* share data with Wilson—for example, at the August 2004 meeting. But as he explained, the

PowerPoint deck containing this data and proving this assertion did not survive from 2004 until January 2013, when Plaintiffs filed this lawsuit.

374. The lack of contemporaneous documentary evidence is particularly prejudicial to Corning because the trial record shows that the witnesses' memories have faded over the course of the lengthy delay.

375. Wilson was the Plaintiffs' principal fact witness. Indeed, the only other fact witness from Wilson Wolf that Plaintiffs called during trial was Welch, Wilson's long-time employee. Welch testified to his limited recollection of only one specific aspect of one meeting with Corning. Wilson also was the only expert to testify for Plaintiffs on liability issues. Plaintiffs' other expert, Ludington, testified only to remedies.

376. Most of Wilson's material testimony was not corroborated.

377. As to Wilson as a witness, the Court highlights that Wilson acknowledged making inaccurate statements both before trial—including under oath during depositions—and under oath during trial. While these inaccurate statements were not always material, they demonstrate a lack of candor and reliability.

378. For example, on the first day of trial, Wilson testified inaccurately about what liquid he used as a demonstrative in a T-225 flask. When asked about this testimony, Wilson acknowledged that he made an inaccurate statement on the first day, claiming it was a mistake. The media testimony was not material to any significant issue in the case but it, along with other testimony in this case, suggests to the Court that Wilson failed to take his oath seriously.

379. Wilson also testified inaccurately about information that was material to this case.

380. Wilson claimed that a photograph of a cell-culture device on a Corning laboratory bench was an image of "the wrapped flask that [he] brought" to Corning. But the device pictured in the exhibit does not resemble any prototype presented by Wilson either to Corning or in Court. And Tanner explained—credibly—that the image was an early Corning SLA, or stereolithography, model of the HYPERFlask device. Tanner explained how she knew this based on details of the image. Tanner's testimony was supported by her contemporaneous laboratory notes, which reflected that she "received SLA tracheal prototypes used to assess liquid handling" shortly before the photo was taken.

381. In addition, Wilson's testimony about what occurred at the various meetings with Corning employees is unsubstantiated, and often contradicted by other credible witness testimony, in material respects. For example, Wilson testified that at the December 2003 trade show he publicly displayed the membrane-based roller bottle and *not* the Vertical Bag. Several Corning witnesses, however, credibly testified that Wilson *did* display the Vertical Bag at the December 2003 trade show. For example, Walsh confirmed that the Vertical Bag prototype that Wilson presented at trial as PTX-10 was a version of the device that Wilson displayed publicly.

382. The Court finds that Wilson was not a credible witness on significant issues. Accepting Plaintiffs' positions at trial would require the Court to conclude that Corning's multiple witnesses, including Martin, Tanner, Titus, Hoover, and Upton, were

lying about the facts of this case. The Court does not make such a conclusion as the Court notes, if it has not previously done so, that it finds the testimony of these witnesses to be credible.

383. Any conclusion of law which may be deemed a finding of fact is incorporated herein as such.

Based on the above Findings of Fact, the Court now makes the following:

CONCLUSIONS OF LAW

I. Trade-Secret Misappropriation

1. Based on the evidence before the Court, the Court finds and concludes that Plaintiffs did not prove their claim of trade-secret misappropriation. Plaintiffs did not prove that Corning used Plaintiffs' information in designing its HYPER products. Plaintiffs did not prove that their alleged trade-secret information qualified as a trade secret that was distinct from information in the prior art (therefore, not generally known or readily ascertainable) and that the information had independent economic value tied to its uniqueness. Finally, the evidence at trial demonstrates that Plaintiffs did not assert their trade secret claim on a timely basis under the Minnesota statute of limitations. Each of these issues provides an independent basis for rejecting Plaintiffs' trade-secret misappropriation claim.

No Wrongful Use

2. At trial, the burden was on Plaintiffs to prove that Corning wrongfully "used" their trade secrets in the process of designing its HYPER products. Minn. Stat. § 325C.01 subdiv. 3(ii) & (ii)(B)(II) (2022). This burden requires more than speculation

based on a showing of the presence of similar elements in both sets of designs; it also requires more than a showing that during the period after interacting with Wilson, Corning launched a product that used gas-permeable membranes. *Sip-Top, Inc. v. Ekco Grp., Inc.*, 86 F.3d 827, 830-33 (8th Cir. 1996) (no liability in the absence of evidence of "how [the defendant] used or divulged confidential information").

3. Plaintiffs did not prove that Corning's design process for the HYPER products used information that Plaintiffs had provided. The HYPER products are multilayer cell-culturing devices that use gas-permeable polystyrene membranes as surfaces for growing cells, with conventional amounts of liquid media above the cells and "tracheal spaces" between the compartments to oxygenate the cells. Evidence at trial demonstrates that this "tracheal flask" design was developed independently by Corning inventors based on their own expertise and ideas already known in the field. Plaintiffs did not prove otherwise; they specifically did not prove that the Corning inventors used anything taken from Plaintiffs.

4. Evidence at trial demonstrates that Corning's independent design process produced a design that is fundamentally different from any of Wilson Wolf's prototypes. For example, unlike the Corning devices—which use thin gas-permeable membranes inside the device—Wilson Wolf's designs used a gas-permeable membrane on the outside. And, whereas Corning's devices have air in "tracheal spaces" between the compartments, Wilson Wolf's multilayer design used hard plastic shelves with no air in between, contained in a single compartment.

5. Corning tested the WW Multilayer Flask/GTF and assisted Wilson in performing his own tests. Based on those tests, Corning concluded that the design did not work to Corning's satisfaction. At trial, Wilson took issue with the testing, but those arguments do not change the fact that from Corning's perspective, the design did not work effectively. This evidence also undermines any claim that Corning "used" Plaintiffs' combinations related to the multilayer design in its own design.

No Trade Secret

6. In addition, Plaintiffs did not prove the existence of a trade secret. A trade secret is information that "(i) derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable by proper means by, other persons who can obtain economic value from its disclosure or use, and (ii) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy." Minn. Stat. § 325C.01 subdiv. 5.

7. A concept already known in the prior art is not a trade secret. *Jostens, Inc. v. Nat'l Comput. Sys., Inc.*, 318 N.W.2d 691, 698 (Minn. 1981) ("Courts agree that trade secrets lie somewhere on a continuum from what is generally known in a field to what has some degree of uniqueness . . . "); *see also Electro-Craft Corp. v. Controlled Motion, Inc.*, 332 N.W.2d 890, 899 (Minn. 1983) ("[M]ere variations on widely used processes cannot be trade secrets.").

8. Before trial, Plaintiffs identified certain combinations that they argued were the "trade secrets" underlying their misappropriation claims. Plaintiffs did not prove that they disclosed these combinations to Corning at the time.

9. Plaintiffs provided the '651 provisional and '814 patent applications confidentially to Corning. Plaintiffs' trade secret claims now go beyond the claims in those patent applications.

10. Plaintiffs assert that the features and combinations were disclosed in the '651 provisional and '814 applications. Plaintiffs have not proven, however, that anything in the '651 provisional application recommended combining the same features in a different way. And to the extent Plaintiffs point to information about the "patent landscape" as a basis for their claim, they have not proven that the description of publicly available information qualified as a trade secret.

11. Moreover, Plaintiffs did not prove that any of their combinations were materially different from the prior art and thus had independent economic value. At trial, Wilson conceded that he was not the first to "come up with" the elements that make up Plaintiffs' alleged trade secret combinations. (11/15/2022 Tr. 14055-21.) In addition, Plaintiffs did not prove that their alleged combinations of these elements were distinct from combinations already known in the prior art—for example, in the Toner patent, the Barbera-Guillem patent, the DiMilla patent, the commercially available OptiCell device, and the Martin/Tanner multiwell plate patent application. The allegedly unconventional idea Plaintiffs emphasized in their written materials to Corning was the idea of using deeper liquid media than was usually employed. That idea is not used or reflected in Corning's HYPER products.

12. Also, Plaintiffs conceded at trial that many of Wilson's ideas were reflected in the Vertical Bag design, which Corning witness Walsh testified that she had previously

seen displayed in public. Although Wilson testified to the contrary, the Court finds that Walsh's testimony is more credible. Plaintiffs did not prove that they kept the Vertical Bag confidential, and therefore they cannot claim as a trade secret any combination revealed by the Vertical Bag's design. *Jostens*, 318 N.W.2d at 700-01 (finding that disclosing alleged secret information to others in the field without requiring confidentiality demonstrates the lack of reasonable efforts to protect the alleged secrets); *Bonito Boats, Inc. v. Thunder Craft Boats, Inc.*, 489 U.S. 141, 155 (1989) (noting the policy "that matter once in the public domain must remain in the public domain;" disclosure of the device also discloses the design).

Statute of Limitations

13. The evidence at trial also demonstrates that Plaintiffs' claim for trade-secret misappropriation is untimely. "An action for misappropriation must be brought within three years after the misappropriation is discovered or by the exercise of reasonable diligence should have been discovered." Minn. Stat. § 325C.06. This Court held on summary judgment that there could not have been any misappropriation after April 21, 2005, when the alleged trade secrets were published. (Doc. No. 388 at 25-26.) As a result, any misappropriation at issue in this case was complete by that date.

14. Plaintiffs' misappropriation claim accrued no later than February 2007, when Corning's patent application relating to the HYPERFlask vessel became public. Wilson also purchased HYPERFlask vessels in the spring of 2007, and he had a series of discussions with Corning representatives in which he specifically raised concerns about the alleged similarity between his device and the HYPERFlask-related patent application

and claimed that Corning had "misappropriated confidential info." Plaintiffs were required to file this claim within the next three years—by early 2010. Plaintiffs did not file their Complaint until 2013. The claim is barred by the statute of limitations.

II. Breach of Contract

15. The Court finds and concludes that Plaintiffs cannot recover for breach of contract. Plaintiffs did not prove a material breach of the CDA. In addition, the evidence at trial confirms that Plaintiffs' breach-of-contract claim is barred by the statute of limitations.

No Material Breach

16. The central question for the contract claim is whether Corning wrongfully "used" Plaintiffs' "Confidential Information." The CDA provides that Corning could "not use received Confidential Information for any purpose other than for the express purpose recited above"—namely, for the purpose of evaluating a potential business relationship with Wilson Wolf.

17. As discussed above in connection with the trade-secret-misappropriation claim, Plaintiffs did not prove that Corning "used" any information provided by Plaintiffs in designing the HYPER products. The evidence at trial convincingly demonstrated that Corning's inventors created that design themselves independently—without using anything taken from Plaintiffs—based on their own experience and information already available in the prior art.

18. To the extent that Plaintiffs' breach-of-contract claims rest on the design contained in their SBIR application, the Court finds that the SBIR application was not disclosed to Corning.

19. Based on the evidence at trial, the Court concludes that the contents of the SBIR application were not disclosed to Corning. Wilson testified that he shared some design elements of the SBIR application at the August 2004 meeting. This testimony is not credible in light of the evidence as a whole. It is contradicted by other testimony at trial. Further, while Wilson Wolf employee Welch testified that he saw a drawing from that application displayed on a computer screen to Corning's Tanner in December 2004, that testimony is also inconsistent with the contemporaneous documents and was contradicted by Tanner. Tanner testified that the image shown on the computer screen was of a different design—a design that Welsh conceded was available at Wilson Wolf at the time. Based on the evidence at trial, the Court finds Tanner's testimony on this point more credible. Plaintiffs did not prove that the SBIR application was disclosed to Corning.

20. In addition, Plaintiffs did not prove that any alleged breach would have been material and caused an injury, which is independently fatal to their breach of contract claim. *Jensen v. Duluth Area YMCA*, 688 N.W.2d 574, 578-79 (Minn. Ct. App. 2004) ("A breach of contract claim fails as a matter of law if the plaintiff cannot establish that he or she has been damaged by the alleged breach."); *see also Reuter v. Jax Ltd.*, 711 F.3d 918, 920 (8th Cir. 2013) (same); *BOB Acres, LLC v. Schumacher Farms, LLC*, 797 N.W.2d 723, 728-29 (Minn. Ct. App. 2011) (explaining that even when express

contractual conditions are violated, the breach is not necessarily material). To constitute a material breach, the breach must go to the root or essence of the contract, such that it defeats an essential purpose of the contract. *Skogberg v. Huisman*, Civ. No. C7-02-2059, 2003 WL 22014576, at *2 (Minn. Ct. App. Aug. 19, 2003); *LeMond Cycling, Inc. v. PTI Holding, Inc.*, Civ. No. 03-5441, 2005 WL 102969, at *4 (D. Minn. Jan. 14. 2005).

21. Plaintiffs did not prove that the information they provided was unique and not already publicly available. The arrangement of cell-culture compartments separated by air spaces was well known, as demonstrated by multiple prior art patents. Any use of publicly available information (whether it had been marked "confidential" or not) would not have caused any damage, nor would it have been a material breach of the CDA.

22. The evidence at trial also establishes that Plaintiffs' contract claim is barred by the six-year statute of limitations. Minn. Stat. § 541.05, subdiv. 1(1).

23. Under Minnesota law, the limitations period for breach of contract begins to run at the time of the breach, regardless of when the plaintiff suffered the claimed damages. *Cardiovascular Sys., Inc. v. Petrucci*, Civ. No. 21-1827, 2022 WL 2133743, at *2 (8th Cir. June 14, 2022) ("There is no mystery about when breach of contract actions accrue in Minnesota."); *Untiedt's Vegetable Farm, Inc. v. S. Impact, LLC*, 493 F. Supp. 3d 764, 768-69 (D. Minn. 2020).

24. Plaintiffs' breach-of-contract claim therefore accrued no later than 2005—the date of the last breach they attempted to prove at trial.

25. Plaintiffs cannot avoid the untimeliness of their claims by asserting fraudulent concealment. Based on the evidence at trial, there is no evidence that Corning

intentionally or affirmatively concealed facts that would establish the cause of action. *See Doe v. Ord. of St. Benedict*, 836 F. Supp. 2d 872, 876 (D. Minn. 2011) ("Fraudulent concealment consists of an intentional and affirmative concealment of the facts which establish the cause of action."). Evidence at trial shows that Corning openly unveiled its HYPERFlask vessel to the industry in September and December 2006, more than six years before this suit was filed.

26. Whether Corning provided formal notice to Plaintiffs of any intention to use confidential information in reliance on any contractual exemptions is not relevant. The evidence at trial showed that Plaintiffs were already on notice of a potential breach in 2005 and affirmatively threatened Corning with a claim for breach in 2007—and yet did not file suit. Plaintiffs cannot point to any lack of notice to avoid the statute of limitations. Further, Plaintiffs have not established that the CDA's notice provision was triggered and that notice was ever required.

Disgorgement Remedy-Laches

27. As a remedy, Plaintiffs seek disgorgement of any profits Corning earned on its HYPER products, as well as any future profits that Corning may earn on its HYPER products through 2026—spanning the term of Corning's '209 patent. Plaintiffs are not entitled to this remedy because they did not prove any wrongful "use" of their confidential information or trade secrets. And even if Plaintiffs had established liability, they would not be entitled to the remedy they seek because of laches.

28. Laches requires proof that "(1) [Wilson Wolf] delayed filing suit for an unreasonable and inexcusable length of time from when it knew or reasonably should

have known of its claim; and (2) the delay operated to the material prejudice" of Corning. *Floe Int'l, Inc. v. Newman's Mfg. Inc.*, Civ. No. 04-5120, 2006 WL 14560, at *3 (D. Minn. Jan. 3, 2006) (patent infringement case). Material prejudice includes both economic and evidentiary prejudice. *Id*. The Court finds that the record here establishes both elements and would make an award of disgorgement fundamentally unfair.

29. As discussed above, Plaintiffs' claims are untimely under the relevant statutes of limitations. This informs the Court's assessment of the reasonableness of the delay and "whether the potential for prejudice was great." *Goodman v. McDonnell Douglas Corp.*, 606 F.2d 800, 804 (8th Cir. 1979) ("In applying the doctrine of laches, an important consideration is the appropriate role of an analogous statute of limitation."); *see, e.g.*, *Minn. & Mining Mfg. Co. v. Beautone Specialties, Co.*, 82 F. Supp. 2d 997, 1004 (D. Minn. 2000) (evidence of a delay exceeding the statute of limitations is strong evidence that the delay was unreasonable). If the delay outside the limitations period is lengthy, "prejudice is more likely to have occurred and less proof of prejudice will be required." *Goodman*, 606 F.2d at 807.

30. Plaintiffs have not offered any legitimate explanation for their delay in filing these claims. The evidence at trial showed that Plaintiffs were aware of a potential claim in 2005, that they threatened claims for breach of contract and trade secret misappropriation in 2007, but that they did not actually file claims in court until 2013. Indeed, in 2010, Wilson wrote "CORNING BATTLE. DELAY AS LONG AS POSSIBLE." This shows that the delay was intentional.

31. Corning presented evidence that this delay caused prejudice. For example, Corning spent millions of dollars to develop, launch, and market its products during the period of delay. An award of equitable relief to Plaintiffs at this late date would cause Corning to "suffer the loss of monetary investments or incur damages which likely would have been prevented by earlier suit." *Floe Int'l*, 2006 WL 14560, at *3 (explaining that economic prejudice may arise where a defendant will suffer loss of monetary investments or damages that would have been avoided by an earlier lawsuit); *Minn. Mining & Mfg.. Co.*, 82 F. Supp. 2d at 1004 (finding economic prejudice where defendant invested millions to manufacture and promote its products).

32. Corning has also demonstrated evidentiary prejudice. *See Floe Int'l*, 2006 WL 14560, at *3 ("Evidentiary prejudice may arise by reason of a defendant's inability to present a full and fair defense on the merits due to the loss of records, the death of a witness, or the unreliability of memories of long past events, thereby undermining the court's ability to judge the facts.") (internal quotations and citations omitted); *Arctic Cat, Inc. v. Injection Rsch. Specialists, Inc.*, 362 F. Supp. 2d 1113, 1122 (D. Minn. 2005) (finding evidentiary prejudice where evidence was destroyed and missing and where several witnesses had forgotten relevant and material facts).

33. Corning has put forth evidence of missing documents—such as the handwritten drawing of the tracheal-space design created by Martin in July 2004 and documents proving that Corning showed Wilson the test results for Wilson Wolf's design—and electronic data. Plaintiffs' case relies heavily on documentary gaps that were caused or exacerbated by Plaintiffs' own delay. Many witnesses testified that they

could not remember details about events nearly 18 years ago. In addition, Wilson admitted that he destroyed audio recordings that might have been helpful to Corning and that he lost emails during the period of delay. Taken separately or together, these examples demonstrate the existence of evidentiary prejudice sufficient to support a finding that laches bars any equitable relief Plaintiffs seek.

34. Plaintiffs seek additional remedies for breach of contract. Because Plaintiffs' breach-of-contract claim fails, they are not entitled to contract remedies.

III. Inventorship Claims

35. Based on the evidence before the Court, the Court finds and concludes that John Wilson's inventorship claims fail both on jurisdictional grounds and on the merits.

Subject Matter Jurisdiction

36. The Court cannot "order correction of [a] patent" without "notice and hearing of all parties concerned . . . ." 35 U.S.C. § 256(b). Inventorship claims require proof of notice to all "named inventors, omitted inventors, and assignees." *Janssen Pharms., Inc. v. Teva Pharms. USA, Inc.*, 571 F. Supp. 3d 281, 339 (D.N.J. 2021) (citation omitted). This is a "prerequisite" for "subject-matter jurisdiction in the district court." *MCV, Inc. v. King-Seeley Thermos Co.*, 870 F.2d 1568, 1570 (Fed. Cir. 1989), *overruled on other grounds* in *Ferring B.V. v. Allergan, Inc.*, 980 F.3d 841 (Fed. Cir. 2020).

37. Plaintiffs have not established compliance with this requirement. The inventorship claims seek to displace or dilute the rights of the Corning inventors named on the patents-at-issue, none of whom had an opportunity to be heard as concerned

parties in this case. (*See* DTX-228, 246 ('209 and '572 Patents, listing Martin and Tanner); DTX-239 ('345 Patent, listing Martin, Tanner, and others).)

38. Martin and Tanner testified at trial as witnesses. Plaintiffs, however, took the position that Martin and Tanner had to be sequestered from the courtroom. The Court concludes that that position is inconsistent with the claim that Martin and Tanner participated in the proceedings as concerned parties.

39. Moreover, there is no evidence that any of the other Corning inventors were given notice of Wilson's inventorship claims.

40. Given this lack of notice, the Court concludes that it lacks subject matter jurisdiction over the inventorship claims and dismisses them under Rule 12(h)(3).

41. Even assuming jurisdiction, however, the Court concludes that Wilson has failed to carry his burden of proving either sole or joint inventorship.

42. "The inventors as named in an issued patent are presumed to be correct." *Hess v. Advanced Cardiovascular Sys., Inc.*, 106 F.3d 976, 980 (Fed. Cir. 1997). Proving a claim for sole inventorship here required clear and convincing evidence that Wilson—and not the named inventors—invented each and every element of every patent claim. *See, e.g., Egenera, Inc. v. Cisco Sys., Inc.*, 972 F.3d 1367, 1376 (Fed. Cir. 2020) ("Inventorship is a claim-by-claim question.").

43. Wilson must also prove that he communicated his invention with the named inventors at the relevant time. *Eli Lilly & Co. v. Aradigm Corp.*, 376 F.3d 1352, 1362-64 (Fed. Cir. 2004).

44. To prove joint inventorship requires clear and convincing evidence that Wilson contributed to the inventive subject matter of at least one claim of the challenged patents. *Ethicon, Inc. v. U.S. Surgical Corp.*, 135 F.3d 1456, 1461 (Fed. Cir. 1998).

45. Wilson did not prove with clear and convincing evidence that he made any contribution to the inventive subject matter of the Corning designs. The evidence at trial showed that Martin and Tanner created their tracheal-flask design independently, without incorporating any contributions from Wilson. In addition, Martin and Tanner completed the basic design of their tracheal flask before either of them were exposed to Wilson's ideas. The patents that they obtained claimed designs that differed significantly from Wilson's designs.

46. Wilson's inventorships claims rest on his testimony. The contemporaneous documents and other evidence presented at trial undermine Wilson's self-serving testimony about his alleged communications with Tanner.

47. Moreover, with respect to the '651 provisional application, the Patent and Trademark Office considered its contents during the prosecutions of the '209 and '572 Patents and found those patents different and patentable over Wilson's alleged inventions.

48. In addition, Wilson acknowledged that he did not contribute to the "continuous flow" element, which the Court has construed to mean "a type of perfusion where liquid medium is continuously flowing through the cell culture vessel." (Doc. No. 854 at 10.) Both the '209 and '572 Patents include continuous flow embodiments within the scope of their claims; they are not limited to static devices. And during an

August 2007 meeting that Wilson secretly recorded, he admitted that Corning's concept of cell-growth compartments separated by tracheal spaces was a "powerful" idea contributed by Corning.

49. For the above reasons, Wilson's inventorship claims fail.

50. Wilson also asserts an inventorship claim as to the '345 Patent. This claim is barred by statute.

51. The application for the '345 Patent was filed on May 30, 2008. This is more than three years after the '651 provisional and '814 patent applications were published. Section 102(b) of the version of the pre-America-Invents-Act applies here. Based on that statute, no one can claim patent rights based on subject matter published more than one year before the application is filed. 35 U.S.C. § 102(b).

52. In addition, Wilson did not prove at trial that he made any contribution to the invention of the '345 patent, which was created after his interactions with Corning ended.

53. For the above reasons, Wilson's claim of inventorship with respect to the '345 patent fails.

54. Any finding of fact which may be deemed a conclusion of law is incorporated herein as such.

Based upon the findings and conclusions of this Court, and the entire record of this case, the Court enters the following:

ORDER FOR JUDGMENT

1. Judgment shall be entered on Plaintiffs' Trade Secret Misappropriation Claim (Count VI) in favor of Corning and against Plaintiffs.

2. Judgment shall be entered on Plaintiffs' Breach of Contract Claim (Count IV) in favor of Corning and against Plaintiffs.

3. Judgment shall be entered on Wilson's Inventorship Claims (Counts I, II, III) in favor of Corning and against Wilson.

4. Corning's Motions to Amend Answer (Doc. Nos. [917, 960]) are **GRANTED** as provided herein.

5. Counts I, II, III, IV, and VI are **DISMISSED WITH PREJUDICE**.

LET JUDGMENT BE ENTERED ACCORDINGLY.

Dated: September 25, 2023

s/Donovan W. Frank
DONOVAN W. FRANK

UNITED STATES DISTRICT COURT
DISTRICT OF MINNESOTA

John R. Wilson and Wilson Wolf Manufacturing Corporation,

Plaintiffs,

v.

Corning, Inc.,

Defendant.

Civil No. 13-210 (DWF/TNL)

MEMORANDUM OPINION AND ORDER

INTRODUCTION

This matter is before the Court on a Motion to Strike Plaintiffs John R. Wilson and Wilson Wolf Manufacturing Corporation's (together, "Plaintiffs" or "Wilson Wolf") Jury Demand brought by Defendant Corning Inc. ("Corning"). (Doc. No. 636.) For the reasons set forth below, the Court grants the motion.

BACKGROUND

The facts of this case have been thoroughly recited in prior orders. In short, Plaintiffs allege that Corning obtained Wilson Wolf's cell-culture technology under a confidentiality agreement (the "CDA") and then wrongfully used that technology to develop and commercialize its own cell-culturing products (i.e., the HYPERFlask and HYPERStack products) and to file for and obtain patents claiming Wilson Wolf's technology as its own. The claims remaining in this action include trade secret misappropriation, breach of contract, and correction of inventorship with respect to certain

Corning patents. The parties dispute whether a right to a jury trial exists with respect to the remaining claims or whether these claims should instead be tried to the bench.

DISCUSSION

A right to a trial by jury stems from a statute or the Seventh Amendment to the United States Constitution. Fed. R. Civ. P. 38(a). The Seventh Amendment provides that "[i]n Suits at common law, where the value in controversy shall exceed twenty dollars, the right of a trial by jury shall be preserved . . . ." U.S. Const. amend. VII. The Supreme Court has held that the Seventh Amendment requires "a jury trial on the merits in those actions that are analogous to 'Suits at common law.'" *Tull v. United States*, 481 U.S. 412, 417 (1987). "Suits at common law" are suits in which legal rights are to be ascertained and determined, in contrast to suits in which equitable rights alone are recognized, and equitable remedies are administered. *See Granfinanciera, S.A. v. Nordberg*, 492 U.S. 33, 41 (1989); *see also City of Monterey v. Del Monte Dunes, Ltd.*, 526 U.S. 687, 719 (1999) (holding that "[i]t is settled law that the Seventh Amendment does not apply" in "suits seeking only injunctive relief" or suits seeking only equitable relief). Courts use a two-prong test to determine whether a party who is seeking to enforce a right is entitled to a jury trial under the Seventh Amendment. *Taylor Corp. v. Four Seasons Greetings, LLC*, 403 F.3d 958, 968 (8th Cir. 2005) (citing *Tull*, 481 U.S. at 417-18). First, courts "compare the statutory action to 18th-century actions brought in the courts of England prior to the merger of the courts of law and equity." *Id*. (quoting *Tull*, 481 U.S. at 417-18). Second, courts "examine the remedy sought and determine whether it is legal or equitable in

nature." *Id*. The second step carries greater weight. *Id*. Below, the Court considers whether Plaintiffs are entitled to a jury trial on each remaining claim.

A. Trade Secret Misappropriation

In Count VI, Wilson Wolf alleges that Corning misappropriated its trade secrets by including them in patent applications it filed beginning in July 2005. (Doc. No. 1 ¶¶ 155-161.) In an order dated March 22, 2016, the Court dismissed Count VI with prejudice insofar as the claim is based on misappropriation after April 21, 2005, the date Wilson's U.S. Patent Application No. 10,961,814 was published.[1] The remedies that Wilson Wolf seeks for trade secret misappropriation include the amount of money to which Corning was unjustly enriched in the form of the disgorgement of all or a percentage of Corning's revenues and/or profits earned on its HYPERFlask and HYPERStack products. Wilson Wolf acknowledges that it seeks unjust enrichment damages based on the amount by which Corning was enriched by its misappropriation of trade secrets but submits that it also seeks compensatory damages for the alleged misappropriation based on the transaction that Wilson Wolf and Corning would have entered into absent the alleged misappropriation.

Wilson Wolf opposes Corning's motion, arguing that its trade secret misappropriation claims brought under the Minnesota Uniform Trade Secrets Act

[1] The Court found that Wilson Wolf could not proceed on any claim of trade secret misappropriation "separate from the information disclosed in the patents." (Doc. No. 388 at 26.) The information was no longer secret when the patent application was published. (Id.)

("MUTSA") are legal in nature and entitled to a jury trial. Wilson Wolf also argues that, even if its claims were under common law, Corning's motion should be denied because while common law claims seeking remedies based on profits may be considered equitable when their aim is to punish a defendant, damages claims based on profits are legal in nature when a defendant's profits are evidence of a plaintiff's losses. Wilson Wolf argues that its compensatory damages are legal in nature because they are based on the agreement that it would have entered into with Corning had Corning paid Wilson Wolf for the technology.[2]

The Court has carefully reviewed the record and considered the parties' respective arguments. Both categories of asserted damages (unjust enrichment and compensatory damages) related to Wilson Wolf's trade secret misappropriation claim are measured by Corning's actual and projected revenues and/or profits on its HYPERFlask and HYPERStack products, as well as projected revenues and/or profits from the sales of products that Wilson Wolf asserts are sold in conjunction with those products. (*See generally* Doc. No. 641, Ex. C ("Ludington Rep.") ¶ 218.)[3] Specifically, the unjust enrichment damages are calculated using Corning's actual and projected revenues and

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[2] Wilson Wolf also argues that, in its March 29, 2017 Order on a Daubert motion, the Court acknowledged that Wilson Wolf's claim is legal, not equitable. (See Doc. No. 461 at 25-26.) However, the Court notes that the issue of the right to a jury trial was not previously before the Court and the Court is not constrained by the prior ruling.

[3] It appears that Wilson Wolf's "compensatory damage" calculation equals the disgorgement of 50% of Corning's profits. In addition, Wilson Wolf does not assert any lost profits or expectation damages separate from the disgorgement calculation.

profits, and for the asserted compensatory damages, Wilson Wolf divides these calculations in half, thereby asserting damages in the amount of 50% of Corning's profits. All of these asserted damages, regardless of how they are labeled, are equitable in nature. *See, e.g.*, *Nat'l Presto Indus., Inc. v. U.S. Merchs. Fin. Grp., Inc.*, Civ. No. 18-3321, 2021 WL 5083934, at *2-3 (D. Minn. Nov. 2, 2021) (finding disgorgement of profits in Lanham Act case is not triable by a jury; explaining that most courts consider a claim for disgorgement of an infringer's profits as an equitable claim for which the Seventh Amendment does not guarantee a right to a jury trial) (collecting cases)); *Fair Isaac Corp. v. Fed. Ins. Co.*, 408 F. Supp. 3d 1019, 1033 (D. Minn. 2019) (finding disgorgement of profits in copyright case is an equitable remedy not entitled to a jury determination).[4] Under the weight of authority under federal law, the equitable remedy of

[4] Wilson Wolf asserts that its damage theory actually represents compensatory damages. The Court disagrees and respectfully rejects this argument for the same reasons articulated in National Presto:

> [Plaintiff] attempts to circumvent this case law by arguing that disgorgement is considered a legal claim when the infringer's profits serve as a "proxy" for the plaintiff's damages. But [Plaintiff's] claim for disgorgement does not actually serve as a proxy for its damages. To be sure, some evidence suggests that [Plaintiff] would have been Costco's exclusive supplier of [some products], and thus the sales that [Defendant] achieved are roughly indicative of the sales [Plaintiff] would have achieved. However, the profits [Defendant] attained are unrelated to the profits [Plaintiff] would have earned. If [Plaintiff] were seeking compensation, rather than restitution and unjust enrichment, it could have argued that it suffered actual damages in the form of lost profits—supported by expert testimony analyzing [Defendant's] sales data to quantify [Plaintiff's] lost sales. [Plaintiff] has not attempted to present such evidence, however. Consequently, its disgorgement claim seeks equitable relief.

disgorgement is not a remedy for which the Seventh Amendment guarantees a right to trial by jury. *See, e.g.*, *Tex. Advanced Optoelectronic Sols., Inc. v. Renesas Elecs. Am., Inc.*, 895 F.3d 1304, (Fed. Cir. 2018) (holding that there was no right to a jury decision on a request for disgorgement of profits as a remedy for trade secret misappropriation); *Nat'l Presto*, Civ. No. 18-3321, 2021 WL 5083934, at *3 (citing cases); *Fair Isaac Corp.*, 408 F. Supp. 3d at 1027-28 ("Moreover, in other seemingly analogous areas of intellectual property–patent and trademark infringement and trade secret misappropriation–judges and scholars have tended to find that disgorgement remedies were the province of equity and not for a jury.") (citing cases).[5] Accordingly, the Court concludes that Wilson Wolf's trade secret misappropriation claim is an equitable claim for which no right to a jury trial exists.

B. Breach of CDA

In Count IV, Wilson Wolf alleges that Corning breached the CDA by developing, commercializing, and filing patent applications related to its own cell-culturing flask technology. (Compl. ¶ 128.) This claim is closely related to Wilson Wolf's trade secret

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2021 WL 5093934, at *3. Notably, Wilson Wolf has not disclosed or quantified lost profits or expectation damages stemming from Corning's alleged trade secret misappropriation.

[5] Wilson Wolf argues that trade secret claims that are based on state statutes modeled on the Uniform Trade Secrets Act ("UTSA"), such as MUTSA, are legal claims entitled to a jury trial, no matter the damages sought. (Doc. No. 654 at 1.) The Court disagrees. Federal law controls the Seventh Amendment right to a trial. In addition, the right to a federal jury trial depends not only on the underlying liability but also the remedies sought. And as discussed above, the weight of federal authority establishes that no right to a jury trial exists for claims seeking only disgorgement.

misappropriation claim in that it seeks the same type of damages—namely, "expectation interest and/or reliance interest damages for breach of contract and disgorgement of profits for opportunistic breach of contract." (Doc. No. 640-2 at Ans. 10.) In addition, Wilson Wolf's expert advances the same theories of damages, unjust enrichment and "compensatory damages," as measured by Corning's actual and projected revenues and/or profits on its HYPERStack, HYPERFlask, and related products. Importantly, with respect to the "compensatory damages" calculation, Wilson Wolf again proposes a 50% disgorgement of Corning's profits. (Doc. No. 641 ¶¶ 215-218.) This calculation is premised on the theory that Wilson Wolf would have received this share of the profits based on a supposed "OEM agreement, a joint venture agreement, a license agreement, or a combination of these" that would reflect a structure that the parties would have agreed to with "the amount of lost profits damages [being the] same as the expectation damages." (*Id.* ¶ 217.)

The parties agree that breach of contract claims seeking reliance or expectation damages were historically tried at law in the English courts. *See, e.g.*, *Dairy Queen, Inc. v. Wood*, 369 U.S. 469, 479 (1962) ("[I]n an action to collect a debt for breach of a contract . . . , petitioner has a right to have the jury determine not only whether the contract has been breached and the extent of the damages if any but also just what the contract is."). Here, the Court previously dismissed Wilson Wolf's unjust enrichment claim with prejudice, finding that the CDA "comprehensively governs the exchange of information between the parties" and thus "there is no legal justification for Plaintiff's claim for unjust enrichment." (Doc. No. 388 at 20-21.) Even so, Wilson Wolf argues that

it is entitled to disgorgement of Corning's profits as a remedy for breach of contract. Specifically, Wilson Wolf submits that its requested damages reflect "lost profit" or "expectation" damages. However, upon examination of the substance of Wilson Wolf's damages analysis, it is apparent that the damage theory is not based on Wilson Wolf's own lost profits. Notably, the alleged damages are not premised on a contract entered into by the parties or any identified products or lost profits of Wilson Wolf, such that any alleged loss to Wilson Wolf could be calculated with reasonable certainty. *See Hinz v. Neuroscience, Inc.*, 538 F.3d 979, 986 (8th Cir. 2008) (explaining that "[i]n limited circumstances, the defendant's gain may be useful in determining the plaintiff's loss," in particular when applying the plaintiff's profit margin only to the portion of the defendant's gross income that is "derived from the plaintiff's former or prospective customers"). Here, Wilson Wolf has not pointed to evidence in the record identifying any lost customers, lost sales, or lost earnings caused by the alleged breach of the CDA. Instead, Wilson Wolf premises the asserted damages on a speculative agreement to split Corning's profits 50/50. After careful review, the Court concludes Wilson Wolf does not seek damages based on its own losses, but rather seeks the equitable remedy of disgorgement. Therefore, Wilson Wolf's breach of contract claim does not give rise to a right to a jury trial. *See, e.g.*, *Marseille Hydro Power, LLC v. Marseilles Land and Water Co.*, 299 F.3d 643, 648 (7th Cir. 2002) ("If the only relief sought is equitable, such as an injunction or specific performance . . . , neither the party seeking that relief nor the party opposing it is entitled to a jury trial.").

C. Inventorship Claims

In Counts I, II, and III, Wilson Wolf alleges that three of Corning's patents should be changed to name Wilson and/or other Wilson Wolf staff as inventors pursuant to 35 U.S.C. § 256. (Compl. ¶¶ 109-111, 113-118.)

Section 256 provides for the correction of a named inventor and reads, in part:

> The error of omitting inventors or naming persons who are not inventors shall not invalidate the patent in which such error occurred if it can be corrected as provided in this section. The court before which such matter is called in question may order correction of the patent on notice and hearing of all parties concerned and the Director shall issue a certificate accordingly.

35 U.S.C. § 256(b). Wilson Wolf concedes that there is no right to a jury trial for its inventorship claims standing alone but asserts that there is a right to a jury trial here because the facts underlying the inventorship claims are common to those underlying Wilson Wolf's claims for breach of contract and trade secret misappropriation. (Doc. No. 652 at 21.) However, because the Court has already determined that Wilson Wolf is not entitled to a jury trial on its trade secret misappropriation or breach of contract claims, Wilson Wolf's inventorship claims are similarly not entitled to a jury trial. Therefore, the Court strikes Wilson Wolf's jury trial demand on its inventorship claims.

CONCLUSION

The Court concludes that the remaining claims seek remedies that are equitable in nature and that the claims are not entitled to a jury trial.

ORDER

Based upon the foregoing, and the files, records, and proceedings herein, **IT IS HEREBY ORDERED** that Corning's Motion to Strike Plaintiffs John R. Wilson and Wilson Wolf Manufacturing Corporation's Jury Demand (Doc. No. [636]) is **GRANTED**.

Dated: June 28, 2022

s/Donovan W. Frank
DONOVAN W. FRANK
United States District Judge

UNITED STATES DISTRICT COURT
DISTRICT OF MINNESOTA

John R. Wilson and Wilson Wolf Manufacturing Corporation,

Plaintiffs,

v.

Corning, Inc.,

Defendant.

Civil No. 13-210 (DWF/TNL)

PRETRIAL ORDER

This matter came before the Court for a pretrial hearing on July 13, 2022. At the pretrial hearing, the Court heard, among other things, the parties' respective motions *in limine*. Based upon the memoranda, pleadings, and arguments of counsel, and for the reasons explained during the hearing, the Court hereby enters the following:

ORDER

1. Plaintiffs' Motion *in Limine* #1 to Preclude Corning from Introducing Evidence of Alleged Invention of the Subject Matter of the '209 Patent Prior to September 9, 2004 (Doc. No. [685]) is **DENIED**. Assuming proper foundation being laid and subject to objections at trial, this evidence survives the Court's Article 4 analysis.

2. Plaintiffs' Motion *in Limine* #3 to Preclude Corning's Damages Expert From Speculating About the Potential Effect of Undisclosed Potential Future Products (Doc. No. [686]) is **provisionally GRANTED**. This evidence is presumptively inadmissible unless and until the relevance of such evidence is made clear to the Court

and such relevance survives a Rule 403 analysis. The Court will entertain a motion to introduce such evidence, should it become appropriate based on testimony received at trial.

3. Plaintiffs' Motion *in Limine* #4 to Exclude Testimony from Undisclosed Experts (Doc. No. [687]) is **provisionally DENIED**. This evidence is presumptively admissible. Assuming proper foundation is laid and subject to objections at trial, the Court concludes that this testimony survives the Court's Article 4 and Article 7 analysis.

4. Plaintiffs' Motion *in Limine* #5 to Preclude Corning From Introducing Testimony or Other Evidence Relating to Wilson Wolf Prototypes Maintained in Corning's Possession (Doc. No. [688]) is **DENIED**. Assuming proper foundation being laid and subject to objections at trial, this evidence survives the Court's Article 4 analysis.

5. Plaintiffs' Motion *in Limine* #6 to Preclude Corning from Testifying About the Section of COR004703A Improperly Withheld as Privileged (Doc. No. [689]) is **provisionally GRANTED**. This evidence is presumptively inadmissible unless and until the relevance of such evidence is made clear to the Court (i.e., to rebut and provide context) and such relevance survives a Rule 403 analysis. The Court will entertain a motion to introduce such evidence, should it become appropriate based on testimony received at trial.

6. Plaintiffs' Motion *in Limine* #7 to Preclude Defendant from Challenging Plaintiffs' Media Sales Calculations (Doc. No. [690]) is **DENIED**. Plaintiffs allege that Defendant refused to produce any information about the actual media sales during fact

and expert discovery. Defendant alleges that Plaintiffs' discovery requests did not mention media sales. Defendant also alleges that media is not sold in conjunction with the HYPER products. Consequently, the fact issue has been created of whether such media sales are "convoyed" sales. Given the objections and issues raised by both Plaintiffs and Defendant, the Court concludes that fact issues remain that go to issues of both credibility and foundation.

7. Plaintiffs' Motion *in Limine* #8 to Exclude Corning Testimony Regarding Cell Culture Media Sales (Doc. No. [691]) is **provisionally DENIED**. This evidence is presumptively admissible as Plaintiffs' objection goes to weight and not admissibility. Moreover, this testimony survives the Court's Article 4 and Article 7 analysis.

8. Plaintiffs' Motion *in Limine* #9 to Preclude Corning from Addressing Plaintiffs' Voluntary Dismissal of Patent Infringement Claims and Unpled Inequitable Conduct Defense (Doc. No. [692]) is **provisionally GRANTED**. This evidence is presumptively inadmissible pursuant to the Court's Article 4 analysis, including Rule 403. The Court reserves the right to revisit and address this issue if either party "opens the door."

9. Plaintiffs' Motion *in Limine* #10 to Exclude Certain Non-Public Documents Produced by Corning After the Close of Fact Discovery (Doc. No. [693]) is **DENIED as premature**. This is another situation where Plaintiffs have alleged discovery violations and the Defendant has either denied the violations or indicated the information has been with Plaintiffs for almost six years. There is a specific issue relating to a 68-page notebook prepared by Defendant's employee David Kenney. Consistent with its ruling,

the Court reserves the right to address any issue related to this document or other documents alleged to be non-public documents based upon testimony at trial.

10. Plaintiffs' Motion *in Limine* #11 to Exclude Evidence Related to a Microcassette Recording (Doc. No. [694]) is **DEFERRED** until such time as the Court has listened to and reviewed the recording. The Court will then make a decision on Plaintiffs' motion.

11. Plaintiffs' Motion *in Limine* #12 Exclude Evidence and Testimony Regarding United States Patent Office Interference Proceeding No. 106,060 (Doc. No. [695]) is **provisionally GRANTED**. This evidence is presumptively inadmissible pursuant to the Court's Article 4 analysis, including Rule 403. The Court reserves the right to revisit and address this issue if either party "opens the door." In light of the Defendant's response to Plaintiffs' Motion *in Limine* #12, the Court anticipates this issue coming up when Mr. Wilson testifies, depending on the opinions that he offers and in the event his testimony is alleged to be contrary to either his testimony during the Interference proceeding or with the position taken by the United States Patents Office.

12. Plaintiffs' Motion *in Limine* #13 to Exclude Testimony as to the Date of COR008164-72, Pursuant to Federal Rules of Evidence 602 and 901 and Federal Rules of Civil Procedure 37(C)(1) (Doc. No. [696]) is **DENIED**. Assuming proper foundation being laid and subject to objections at trial, this evidence survives the Court's Article 4 analysis.

13. Plaintiffs' Motion *in Limine* #14 to Exclude Corning's Supplementation Consisting of Previously Unproduced Sales, Cost, and Profit Information (Doc.

No. [697]) is **DENIED AS MOOT** in light of the Court's ruling on Corning's Motions in Limine Nos. 10 & 14.

14. Plaintiffs' Motion *in Limine* #15 to Exclude the First and Second Supplemental Reports of Defendant Corning, Inc.'s Damages Expert, Frances M. McCloskey (Doc. No. [698]) is **DENIED**. While the court acknowledges the rebuttal report deadline issue raised by Plaintiffs along with new opinions and asserted new methodology, the Court finds that these issues go to the weight and credibility to be given to the evidence assuming that proper foundation is established for the admissibility of the opinions of Frances L. McCloskey.

15. Plaintiffs' Motion *in Limine* #16 to Exclude the Supplemental Expert Reports of Charles Crespi and Eric Simon (Doc. No. [699]) is **DENIED**. Given the allegations of both Plaintiffs and Defendant, the Court views these issues as fact issues with respect to the relationship of the '044 Patent, the alleged trade secrets and confidential information Plaintiffs have identified as a basis for its claims in the case. Consequently, especially given the fact that it is a Court trial, these issues will likely go to the weight to be given to the evidence rather than its admissibility and outright exclusion subject to objections being made and Rule 104 offers of proof depending on the direct and cross-examination of witnesses whether called by Plaintiffs or Defendant.

16. Corning's Motion *in Limine* #1 (to exclude evidence of trade secrets and/or misappropriation; or, at a minimum, to limit any references to and evidence of alleged "trade secrets" or misappropriation to those allowed by this Court's prior summary judgement rulings (Doc. Nos. 388, 461)) (Doc. No. [728]) is **GRANTED IN PART**

AND DENIED IN PART as follows: In the context of the Court's prior rulings (Doc. at 388 at 22-26; Doc. at 461 at 4 n.4) and consistent with the Court's analysis of Article 4 of the Federal Rules of Evidence, Plaintiffs' trade secret evidence and arguments regarding combinations, are limited to those asserted within Wilson's '651 and '814 applications and identified in Interrogatory No. 1. Furthermore, the Court will require the parties to meet and confer and for Plaintiffs to reduce the number of alleged trade secret combinations they wish to try. The Court reserves the right of each party to address that issue before the Court in a Rule 104 offer of proof.

17. Corning's Motion *in Limine* #2 (to exclude evidence of and references to disclosures that were never marked "confidential") (Doc. No. [728]) is **provisionally GRANTED**. This evidence is presumptively inadmissible pursuant to the Court's Article 4 analysis, including Rule 403.

18. Corning's Motion *in Limine* #3 (to exclude evidence of and arguments regarding uses of information permitted by the CDA attached to Plaintiffs' summary judgment briefing (Doc. No. 314, Young Decl. Exs. 3 (testimony cited), 4, 8, 10, 13-17, 19-21, 23-27, 29-30, 31 (testimony cited), 35-41, 44-47, 49-50, 52-53) (Doc. No. [728]) is **provisionally DENIED**. Subject to proper foundation being laid, this evidence is presumptively admissible pursuant to the Court's Article 4 analysis, including Rule 403.

19. Corning's Motion *in Limine* #4 (to exclude evidence of and arguments relating to alleged contract breaches not pleaded or inconsistent with pleaded allegations) (Doc. No. [728]) is **provisionally GRANTED**. This evidence is presumptively inadmissible pursuant to the Court's Article 4 analysis, including Rule 403. In light of

the Court's earlier ruling in Doc. No. 461, p. 34, in the event there are objections to the scope or nature of the testimony of Mr. Wilson, the Court will address those issues at that time during the trial including a Rule 104 offer of proof by either Plaintiffs or Defendant.

20. Corning's Motion *in Limine* # 5 (to exclude testimony regarding promises to commercialize) (Doc. No. [728]) is **provisionally GRANTED**. This evidence is presumptively inadmissible pursuant to the Court's Article 4 analysis, including Rule 403.

21. Corning's Motion *in Limine* #6 (to exclude evidence of and arguments that would relitigate the final judgment of the Patent Trial & Appeal Board or its finding that the Toner patent teaches multi-level static cell-culturing devices using gas-permeable membranes) (Doc. No. [728]) is **provisionally GRANTED**. This evidence is presumptively inadmissible pursuant to the Court's Article 4 analysis, including Rule 403.

22. Corning's Motion *in Limine* #7 (to exclude extended testimony of John R. Wilson's other business ventures) (Doc. No. [728]) is **provisionally GRANTED**. This evidence is presumptively inadmissible pursuant to the Court's Article 4 analysis, including Rule 403. However, given the Court's earlier ruling (Doc. No. 461 at pp. 36-37, the Court will consider a Rule 104 offer of proof from Plaintiffs' counsel addressing the admissibility of Wilson's testimony involving a discussion of his G-Rex production as part of establishing his credentials. (See Doc. No. 461 at 37 with respect to the Court's ruling on this issue.)

23. Corning's Motion *in Limine* #8 (to exclude evidence or testimony of impressions or testing of the "Vertical Bag" (later commercialized by Wilson Wolf as the G-Rex)) (Doc. No. [728]) is **provisionally DENIED**. Subject to proper foundation being laid, this evidence is presumptively admissible pursuant to the Court's Article 4 analysis, including Rule 403. Assuming proper foundation is established, this issue goes to the weight the Court should afford, if any, to the testimony, not its admissibility.

24. Corning's Motion *in Limine* #9 (to exclude evidence of Corning's estimated profits over the lifespan of its patents because such a theory is preempted) (Doc. No. [739]) is **provisionally DENIED**, consistent with the Court's prior ruling (Doc. No. 461 pp. 22-30) and subject to proper foundation being laid, this evidence shall be presumptively admissible pursuant to the Court's Article 4 and Article 7 analysis.

25. Corning's Motion *in Limine* #10 (to exclude evidence of remedies not temporally limited as required by law, including remedies beyond a five-year restriction period and any remedies seeking disgorgement of unrealized gains) (Doc. No. [739]) is **DENIED.** Consistent with the Court's earlier analysis (Doc. 461 at 22-30) subject to proper foundation being laid, this evidence is presumptively admissible pursuant to the Court's Article 4 and Article 7 analysis. Once all evidence has been submitted to the Court at trial, if there remains an issue about the proper measure of damages, the Court will let counsel address that issue at that time.

26. Corning's Motion *in Limine* #11 (to preclude Wilson Wolf from offering evidence of Corning's profits as a remedy for breach of contract) (Doc. No. [739]) is **provisionally DENIED** to the extent plaintiff is seeking unjust enrichment and

compensatory damages for trade secret misappropriation and breach of contract. Consistent with the Court's earlier ruling (Doc. No. 461 at 22), subject to proper foundation being laid, this evidence is presumptively admissible pursuant to the Court's Article 4 and Article 7 analysis.

27. Corning's Motion *in Limine* #12 (to exclude evidence of profits of media sales) (Doc. No. [739]) is **provisionally GRANTED**. This evidence is presumptively inadmissible pursuant to the Court's Article 4 analysis, including Rule 403.

28. Corning's Motion *in Limine* #13 (to exclude references to hypothetical contracts) (Doc. No. [739]) is **GRANTED**.

29. Corning's Motion *in Limine* #14 (to exclude remedies not disclosed in discovery) (Doc. No. [739]) is **GRANTED**. This evidence is inadmissible pursuant to the Court's Article 4 analysis, including Rule 403.

30. Corning's Motion *in Limine* #15 (to exclude John Wilson's testimony regarding oral conversations because plaintiffs destroyed his recordings of those conversations) (Doc. No. [747]) is **provisionally DENIED**. Subject to proper foundation being laid, this evidence is presumptively admissible pursuant to the Court's Article 4 analysis, including Rule 403. However, based upon the testimony presented during the trial including the direct and cross-examination of John Wilson, the Court reserves the right to draw adverse inferences where warranted.

31. Corning's Motion *in Limine* #16 (to preclude references to "inventorship" claims that the parties agree are beyond the issues for the jury) (Doc. No. [747]). It is the Court's understanding that now that this matter is proceeding to a trial before the Court

and not a jury, that this issue will be presented to the Court. In the event either party wants to be heard by way of an additional Rule 104 offer of proof, the Court will take this up at the time of trial or prior to trial.

32. Corning's Motion *in Limine* #17 (to exclude references to John Wilson as the Plaintiff for the inventorship claims) (Doc. No. [747]) is **provisionally DENIED**. Subject to proper foundation being laid, this evidence is presumptively admissible pursuant to the Court's Article 4 analysis, including Rule 403.

33. Corning's Motion *in Limine* #18 (to exclude improper opening statement and arguments of counsel) (Doc. No. [747]) is **provisionally DENIED**, given that this will be a Court trial, and subject to any objections respective counsel make during opening statements.

34. Corning's Motion *in Limine* #19 (to preclude argument and evidence of Corning's size and wealth) (Doc. No. [747]) is **provisionally DENIED**. Subject to proper foundation being laid, this evidence is presumptively admissible pursuant to the Court's Article 4 analysis, including Rule 403.

35. Corning's Motion *in Limine* #20 (to preclude argument and evidence about discovery disputes) (Doc. No. [747]) is **provisionally DENIED**. Given the number of arguments by both parties involving asserted discovery violations, the Court will evaluate such disputes as they arise and will reserve the right to draw adverse inferences where appropriate.

Dated: July 21, 2022

s/Donovan W. Frank
DONOVAN W. FRANK
United States District Judge

US007745209B2

(12) **United States Patent**
Martin et al.

(10) **Patent No.: US 7,745,209 B2**
(45) **Date of Patent: Jun. 29, 2010**

(54) **MULTILAYERED CELL CULTURE APPARATUS**

(75) Inventors: **Gregory R. Martin**, Acton, ME (US); **Allison J. Tanner**, Portsmouth, NH (US)

(73) Assignee: **Corning Incorporated**, Corning, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 280 days.

(21) Appl. No.: **11/433,859**

(22) Filed: **May 11, 2006**

(65) **Prior Publication Data**

US 2007/0026516 A1 Feb. 1, 2007

Related U.S. Application Data

(60) Provisional application No. 60/702,896, filed on Jul. 26, 2005.

(51) **Int. Cl.**
C12M 1/20 (2006.01)

(52) **U.S. Cl.** **435/294.1**; 435/304.3

(58) **Field of Classification Search** ..... None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,225,671	A	9/1980	Puchinger et al.	435/71
4,296,205	A	10/1981	Verma	435/240
4,661,455	A	4/1987	Hubbard	435/240
4,734,373	A	3/1988	Bartal	435/296
4,748,124	A	5/1988	Vogler	435/240.241
4,770,854	A	9/1988	Lyman	422/102
4,839,292	A	6/1989	Cremonese	435/313
4,938,196	A	7/1990	Hoshi et al.	123/489
4,945,203	A	7/1990	Soodak et al.	219/121.64
5,026,650	A	6/1991	Schwarz et al.	435/286
5,047,347	A	9/1991	Cline	435/296
5,079,168	A	1/1992	Amiot	437/284
5,139,946	A	8/1992	Howell et al.	435/240.2
5,149,649	A	9/1992	Miyamori et al.	435/240.242
5,153,131	A	10/1992	Wolf et al.	435/240.24
5,310,676	A	5/1994	Johansson et al.	435/285
5,330,908	A	7/1994	Spaulding	435/240.24
5,416,022	A	5/1995	Amiot	435/284
5,437,998	A	8/1995	Schwarz et al.	435/286
5,476,573	A	12/1995	Hirose et al.	202/197
5,523,236	A	6/1996	Nuzzo	435/304.1
5,527,705	A	6/1996	Mussi et al.	435/297.1
5,565,353	A	10/1996	Klebe et al.	435/240.25
5,589,112	A	12/1996	Spaulding	264/413
5,597,731	A	1/1997	Young et al.	435/284.1
5,602,028	A	2/1997	Minchinton	435/401
5,627,070	A	5/1997	Gruenberg	435/786.5
5,658,797	A	8/1997	Bader	435/284.1
5,686,301	A	11/1997	Falkenberg et al.	435/297.1
5,686,304	A	11/1997	Codner	435/325
5,693,537	A	12/1997	Wilson et al.	435/401
5,702,941	A	12/1997	Schwarz	435/243
5,714,384	A	2/1998	Wilson et al.	435/401
5,763,261	A	6/1998	Gruenberg	435/286.5
5,763,275	A	6/1998	Nagels et al.	435/373
5,763,279	A	6/1998	Schwarz et al.	435/383
5,783,440	A	7/1998	Stevens	435/304.3
5,786,215	A	7/1998	Brown et al.	435/401
5,801,054	A	9/1998	Kiel	435/297.5
5,912,177	A	6/1999	Turner et al.	435/455
5,924,583	A	7/1999	Stevens et al.	215/40
6,107,085	A	8/2000	Coughlin et al.	435/299.1
6,114,165	A	9/2000	Cai et al.	435/304.3
6,190,913	B1	2/2001	Singh	435/394
6,297,046	B1	10/2001	Smith et al.	435/297.5
6,323,022	B1	11/2001	Chang et al.	435/286.5
6,410,309	B1	6/2002	Barbera-Guillem et al.	435/297.5
6,455,310	B1	9/2002	Barbera-Guillem	435/383
6,465,243	B2	10/2002	Okada et al.	435/301.1
6,468,792	B1	10/2002	Bader	435/325
6,518,035	B1	2/2003	Ashby et al.	435/18
6,548,263	B1	4/2003	Kapur et al.	435/7.2
6,555,365	B2	4/2003	Barbera-Guillem et al.	435/303.1

(Continued)

FOREIGN PATENT DOCUMENTS

EP	155237 B1	5/1989
EP	0 725 134	8/1996
EP	0 890 636	10/2001
GB	1 539 263	1/1979

(Continued)

OTHER PUBLICATIONS

"Cell Culture Equipment (Hardware & Devices)", Lab Times, Products, Jan. 2006, pp. 52-58.

E. Barbera-Guillem, "Overcoming cell culture barriers to meet the demands of cell biology and biotechnology", Reprinted from American Biotechnology Laboratory, May 2001.

E. Metzen, M. Wolff, J. Fandrey, and W. Jelkmann, Pericellular PO2 and O2 consumption in monolayer cell cultures, Respiration Physiology 100 (1995) 101-106.

(Continued)

Primary Examiner—James S Ketter
(74) *Attorney, Agent, or Firm*—Susan S. Wilks; Thomas R. Beall

(57) **ABSTRACT**

A multilayered cell culture apparatus for the culturing of cells is disclosed. The cell culture apparatus is defined as an integral structure having a plurality of cell culture chambers in combination with tracheal space(s). The body of the apparatus has imparted therein gas permeable membranes in combination with tracheal spaces that will allow the free flow of gases between the cell culture chambers and the external environment. The flask body. also includes an aperture that will allow access to the cell growth chambers by means of a needle or cannula. The size of the apparatus, and location of an optional neck and cap section, allows for its manipulation by standard automated assay equipment, further making the apparatus ideal for high throughput applications.

40 Claims, 10 Drawing Sheets

U.S. PATENT DOCUMENTS

6,569,675	B2	5/2003	Wall et al.	435/304.2
6,576,458	B1	6/2003	Sarem et al.	435/286.5
6,588,586	B2	7/2003	Abasolo et al.	206/204
6,593,136	B1	7/2003	Geiss	435/325
6,653,124	B1	11/2003	Freeman	435/297.1
6,673,595	B2	1/2004	Barbera-Guillem	435/286.2
6,759,245	B1	7/2004	Toner et al.	435/401
6,794,184	B1	9/2004	Mohr et al.	435/294.1
6,811,752	B2	11/2004	Barbera-Guillem	422/100
6,818,438	B2	11/2004	Muser	435/304.3
6,821,772	B2	11/2004	Barbera-Guillem et al.	435/297.5
6,841,384	B2	1/2005	Robbins, Jr.	435/325
6,855,542	B2	2/2005	DiMilla et al.	435/289.1
6,908,767	B2	6/2005	Bader	435/395
7,022,518	B1	4/2006	Feye	435/297.1
7,078,228	B2	7/2006	Lacey et al.	435/288.1
7,160,687	B1	1/2007	Kapur et al.	435/7.2
7,192,769	B2	3/2007	Pykett et al.	435/373
7,195,758	B2	3/2007	Schultze et al.	424/93.71
2002/0039785	A1	4/2002	Schroeder et al.	435/304.3
2002/0110905	A1	8/2002	Barbera-Guillem et al.	435/294.1
2003/0008388	A1	1/2003	Barbera-Guillem et al.	435/297.5
2003/0008389	A1	1/2003	Carll	435/302.1
2003/0040104	A1	2/2003	Barbera-Guillem	435/286.2
2003/0143727	A1	7/2003	Chang	435/289.1
2004/0029266	A1	2/2004	Barbera-Guillem	435/297.5
2004/0043481	A1	3/2004	Wilson	435/297.1
2004/0132175	A1	7/2004	Vetillard et al.	435/297.1
2005/0009179	A1	1/2005	Gemmiti et al.	435/420
2005/0032208	A1	2/2005	Oh et al.	435/366
2005/0077225	A1	4/2005	Usher et al.	210/321.6
2005/0101009	A1	5/2005	Wilson et al.	435/295.3
2005/0106717	A1	5/2005	Wilson et al.	435/297.5
2005/0169962	A1	8/2005	Bhatia et al.	424/423
2005/0260745	A1	11/2005	Domansky et al.	435/294.1
2006/0003436	A1	1/2006	DiMilla et al.	435/284.1
2006/0019361	A1	1/2006	Ng et al.	435/177
2006/0031955	A1	2/2006	West et al.	800/24
2006/0112438	A1	5/2006	West et al.	800/17
2006/0121606	A1	6/2006	Ito et al.	435/325
2006/0136182	A1	6/2006	Vacanti et al.	703/11
2006/0141617	A1	6/2006	Desai et al.	435/325
2006/0252150	A1	11/2006	Cheng	435/372
2007/0026516	A1	2/2007	Martin et al.	435/297.5
2008/0176318	A1	7/2008	Wilson et al.	435/297.1
2008/0227176	A1	9/2008	Wilson	435/243

FOREIGN PATENT DOCUMENTS

WO	WO 90/05179	5/1990
WO	WO 91/15570	10/1991
WO	WO 00/56870	9/2000
WO	WO 00/78932	12/2000
WO	WO 01/92462	12/2001
WO	WO/02/066595	8/2002
WO	WO 03/085080	10/2003
WO	WO 2004/106484	12/2004
WO	WO 2005/035728	4/2005

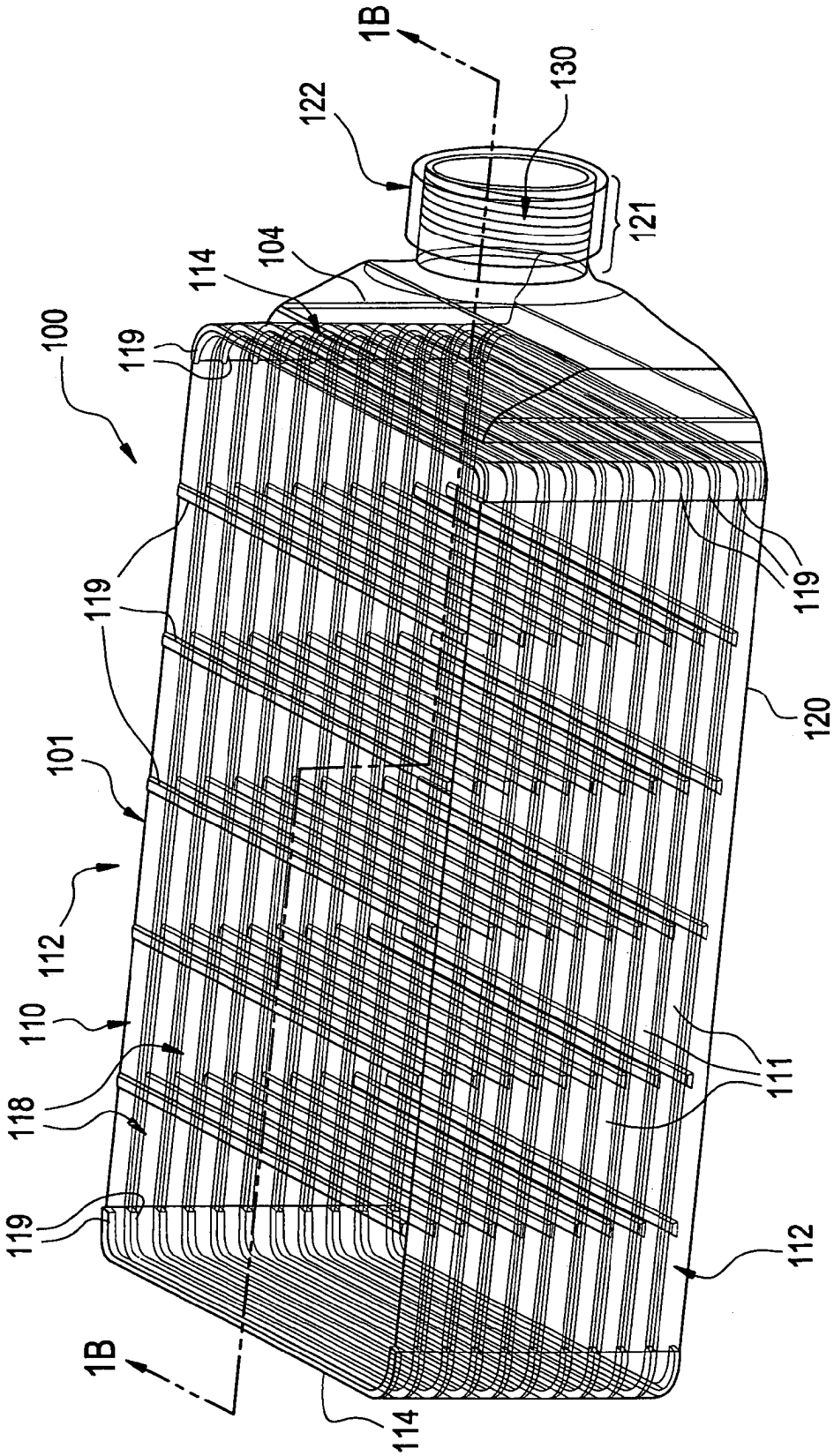
OTHER PUBLICATIONS

Kamel Mamchaoui and Georges Saumon, A method for measuring the oxygen consumption of intact cell monolayers, American Journal of Physiology Lung Cellular and Molecular Physiology (2000) 278: L858-L863.

Derwent Abstract for EP155236, (2007).

US 6,465,252, 10/2002, Toner et al. (withdrawn)

FIG. 1A


1B
130
122
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1B
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FIG. 1B

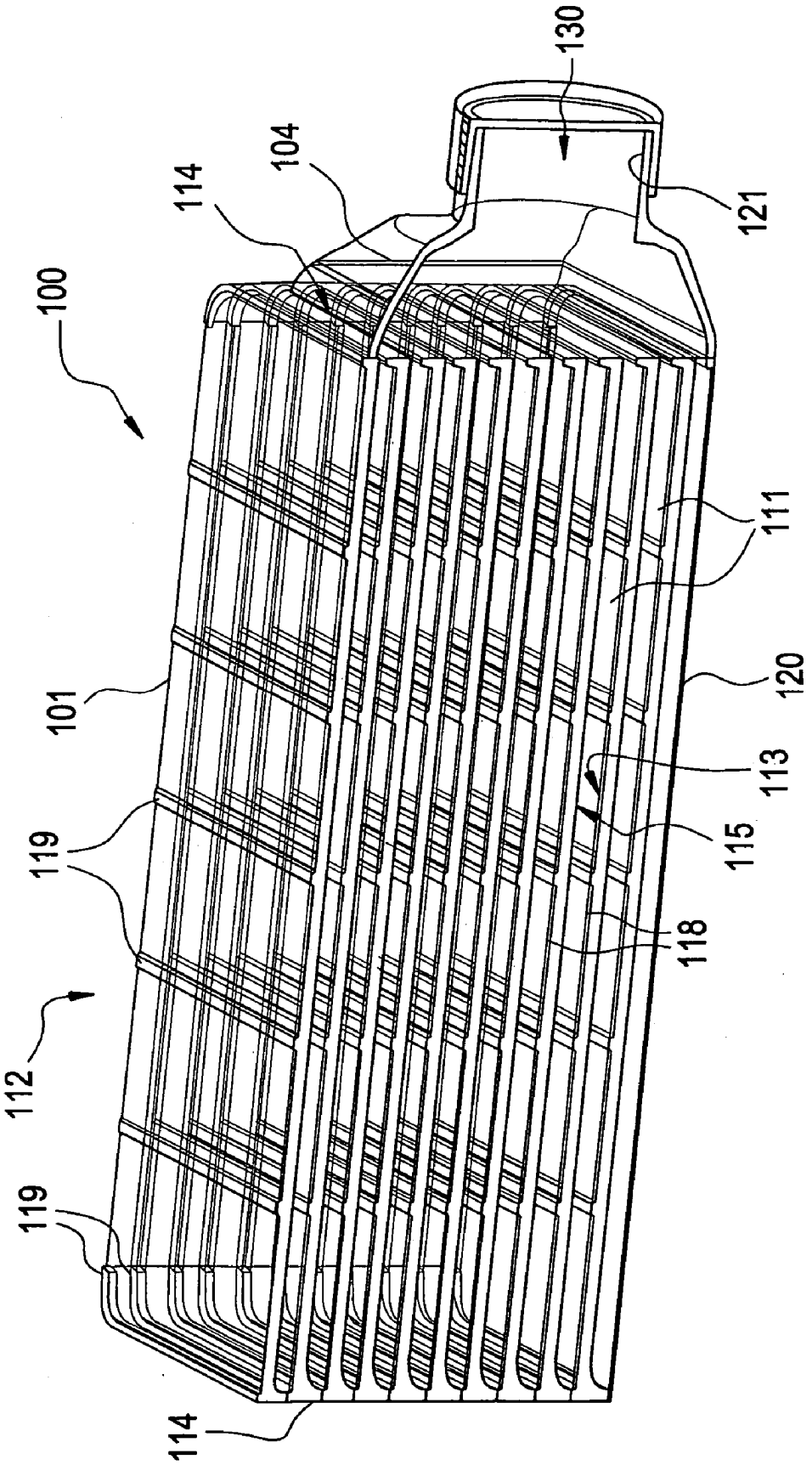


FIG. 1C

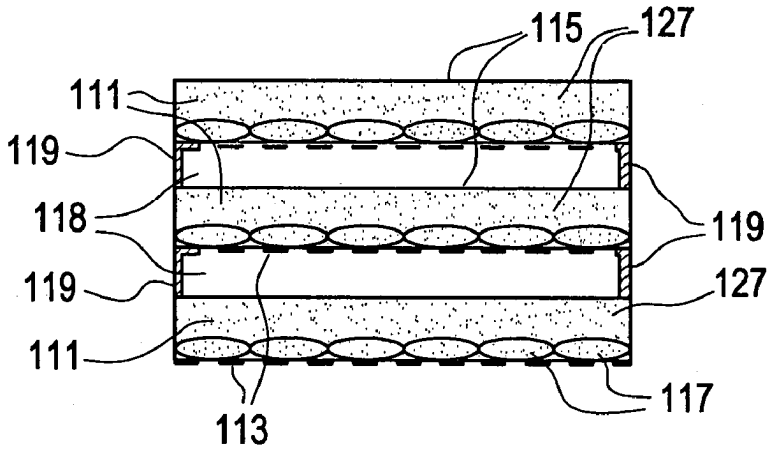


FIG. 2

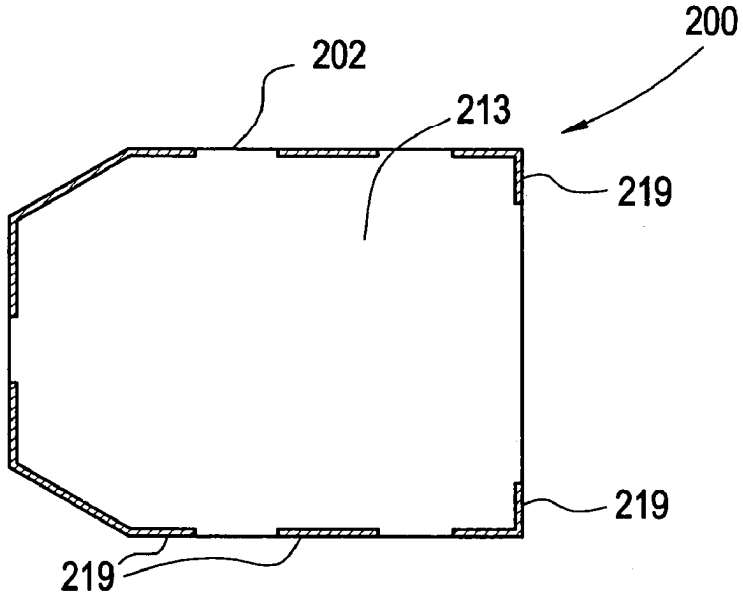
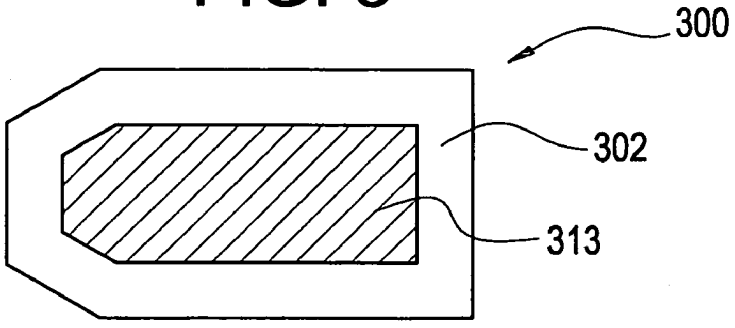


FIG. 3



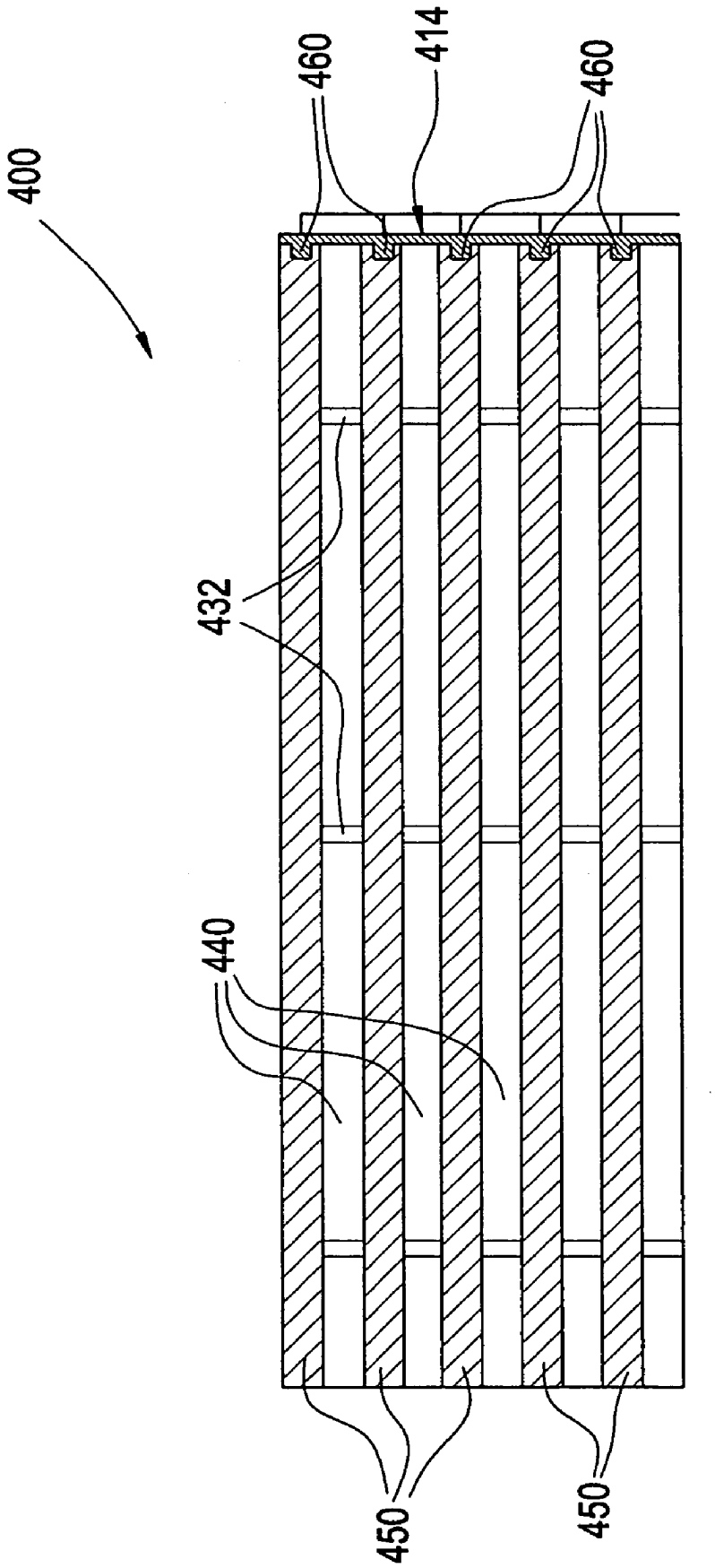


FIG. 4

FIG. 5

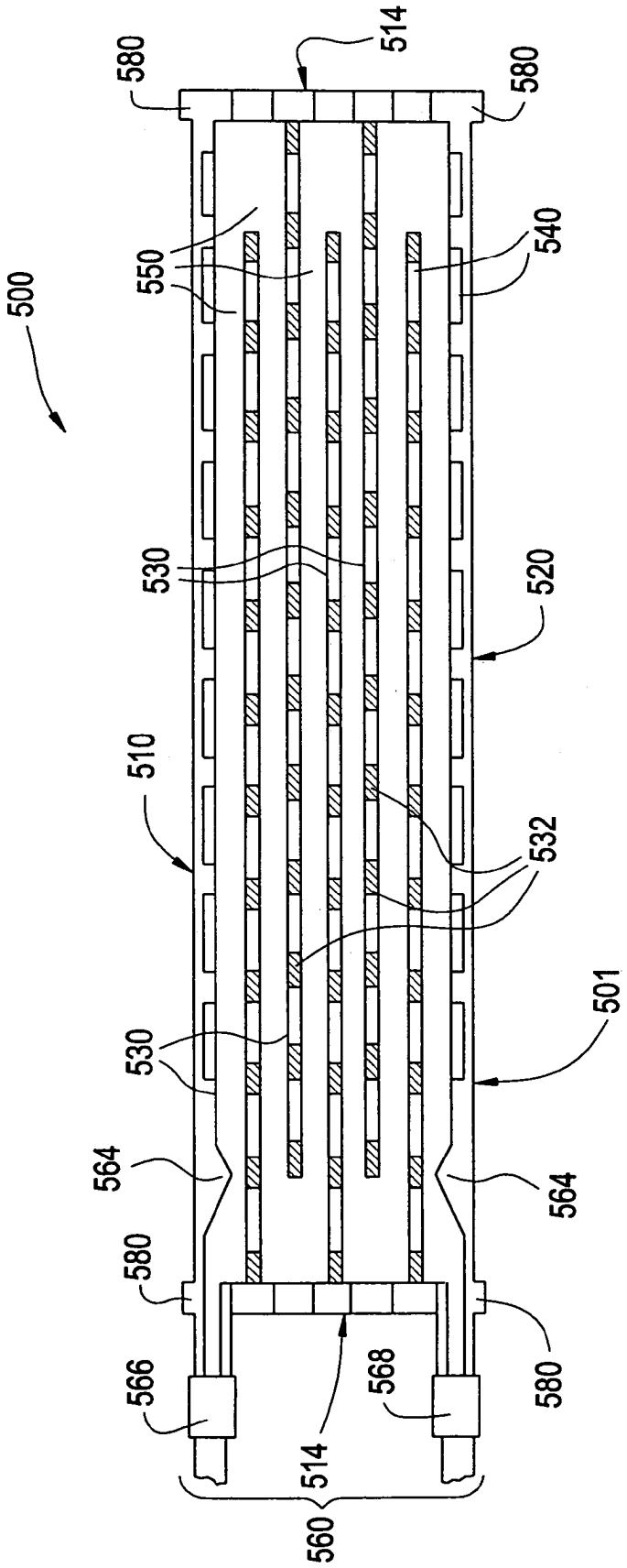


FIG. 5A

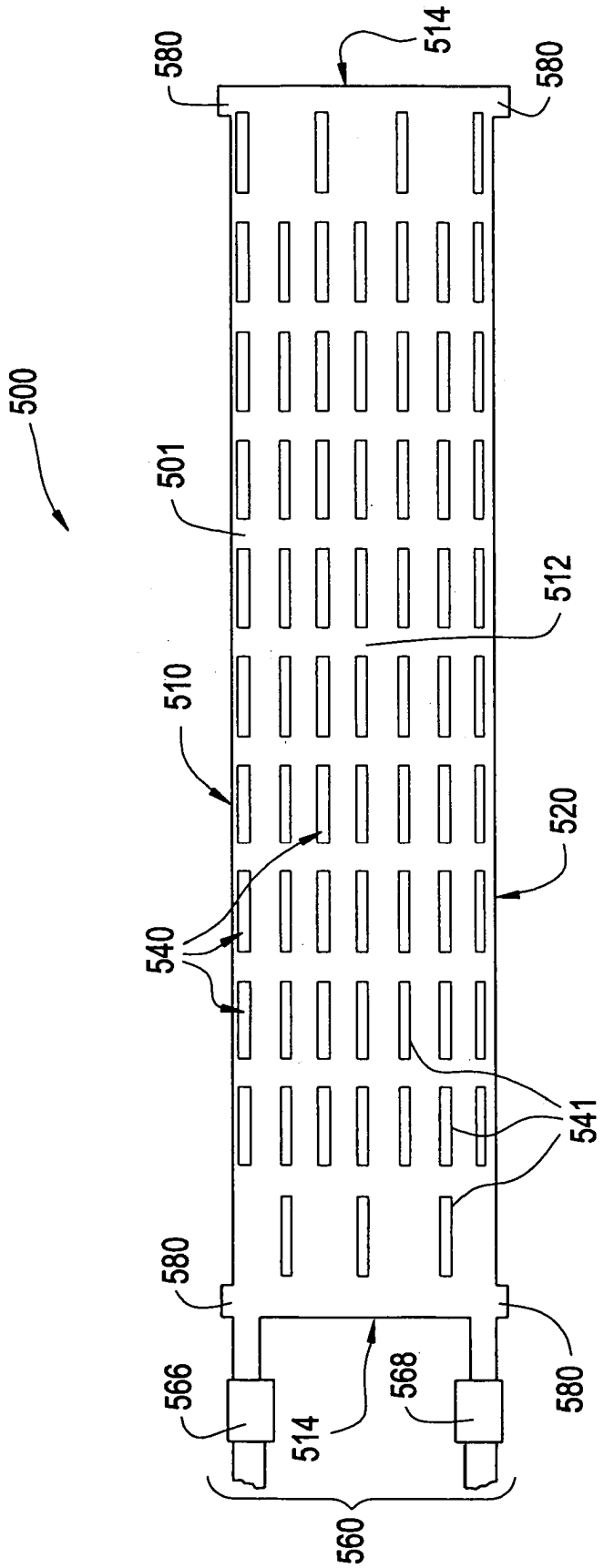


FIG. 6

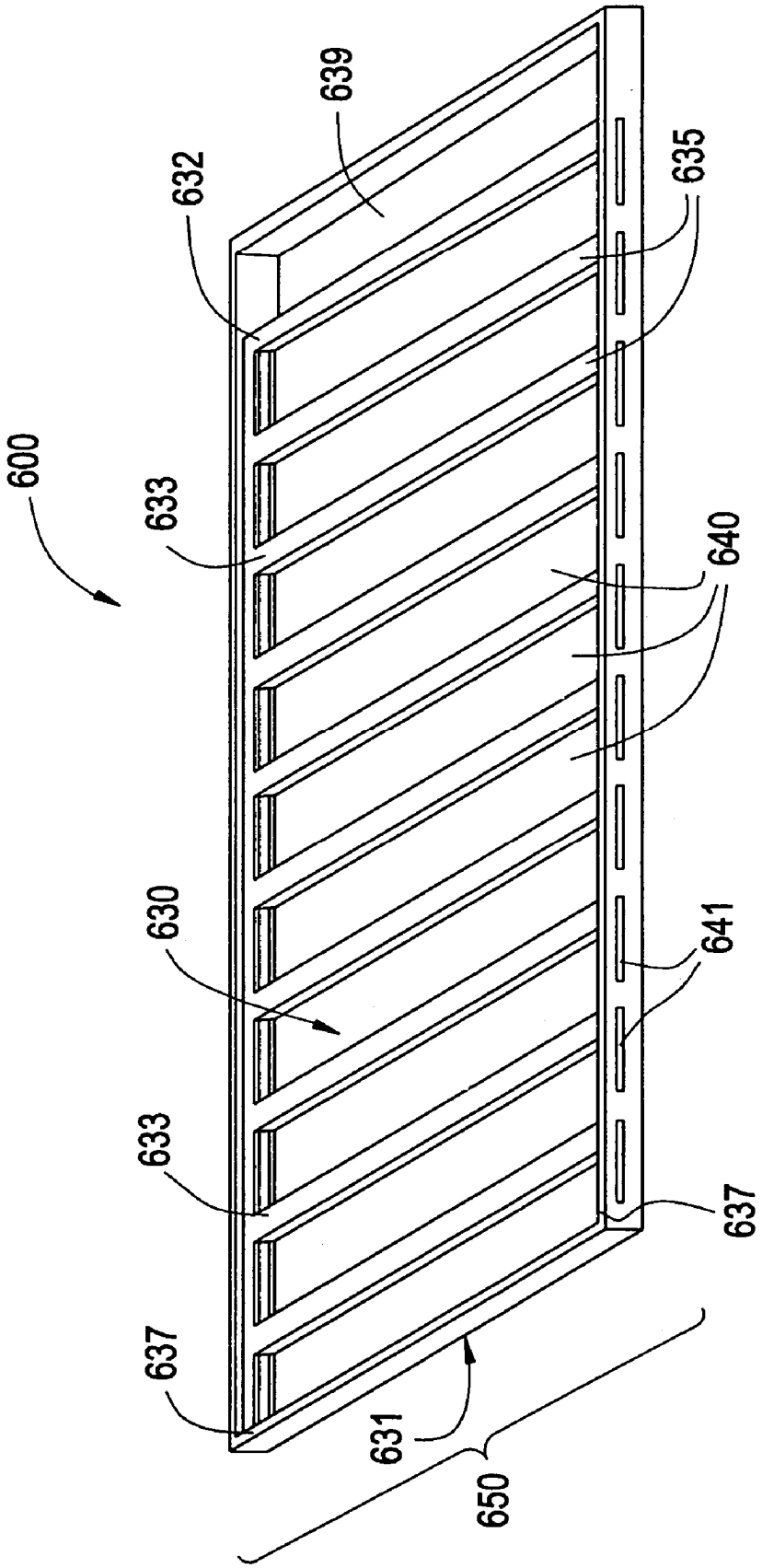


FIG. 7

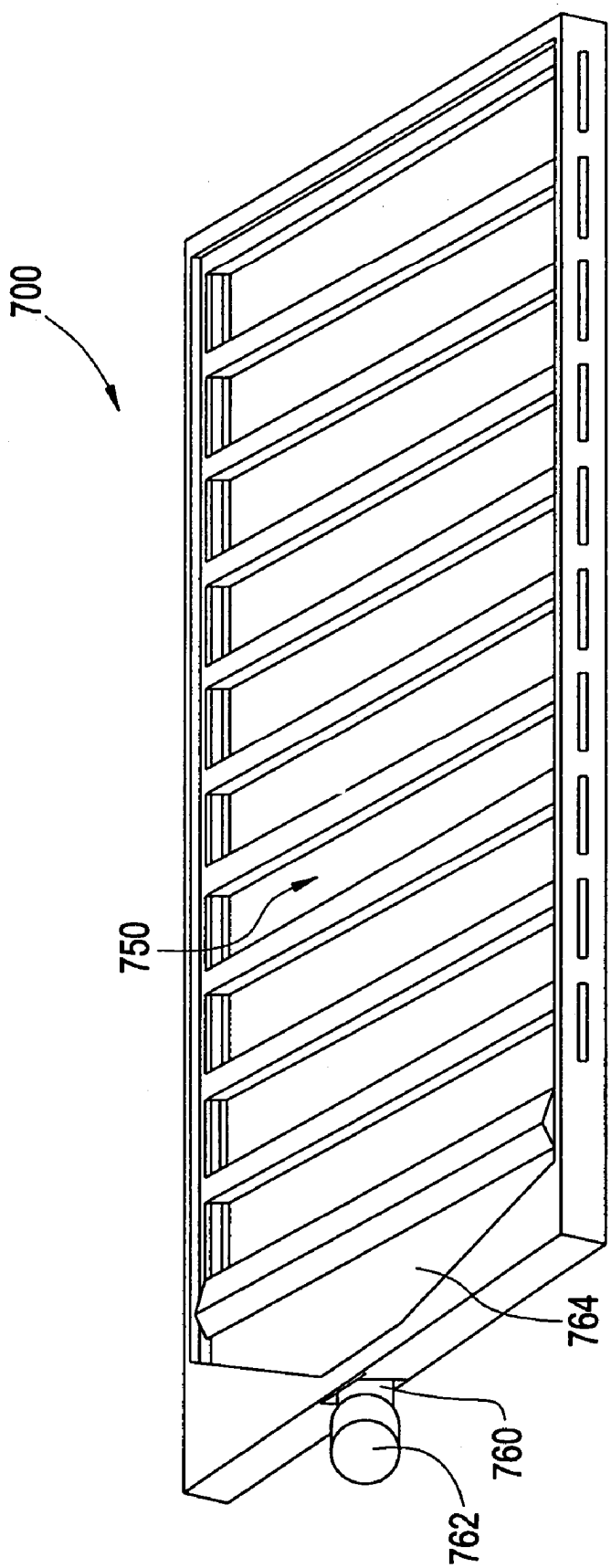


FIG. 8

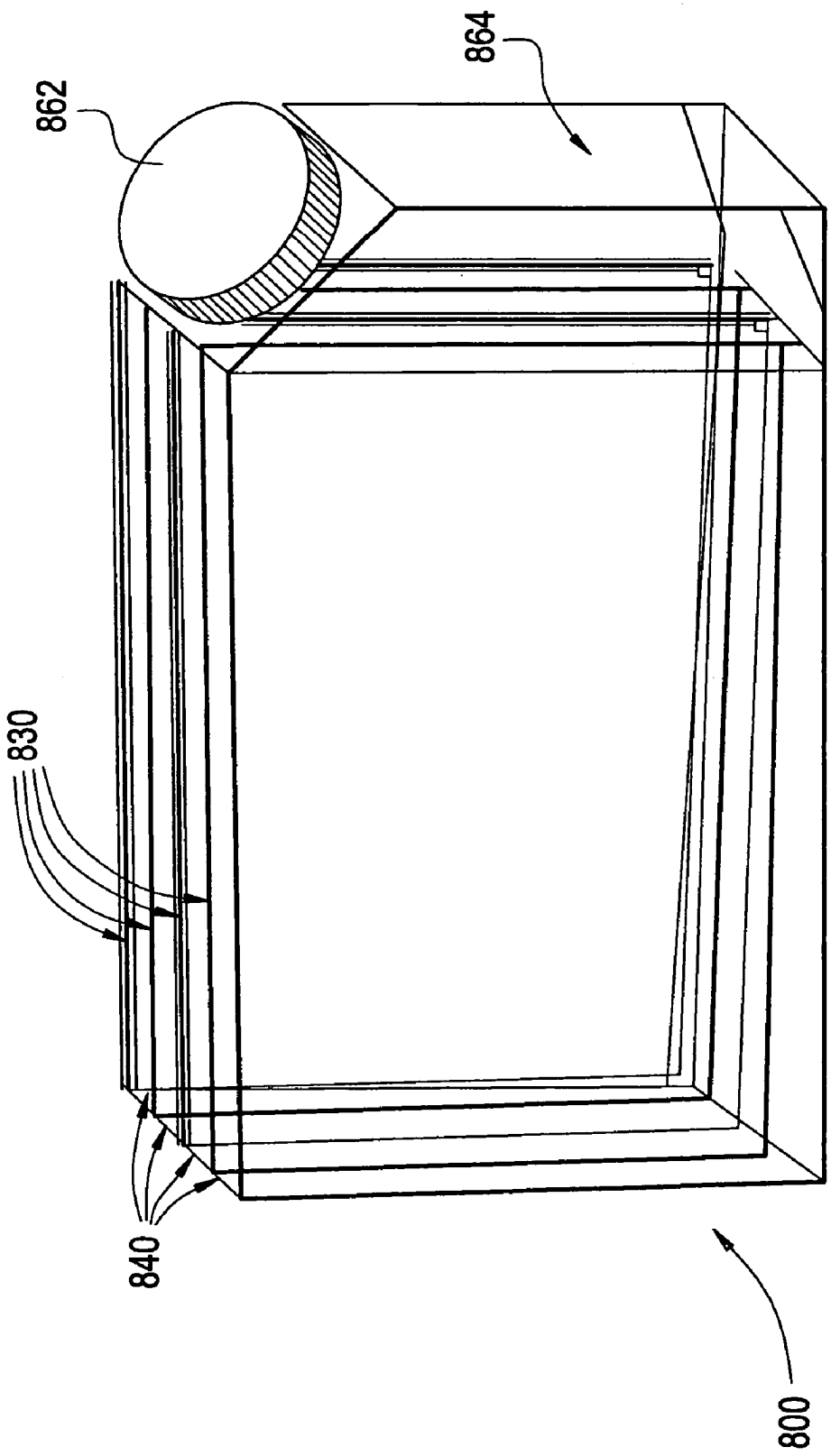
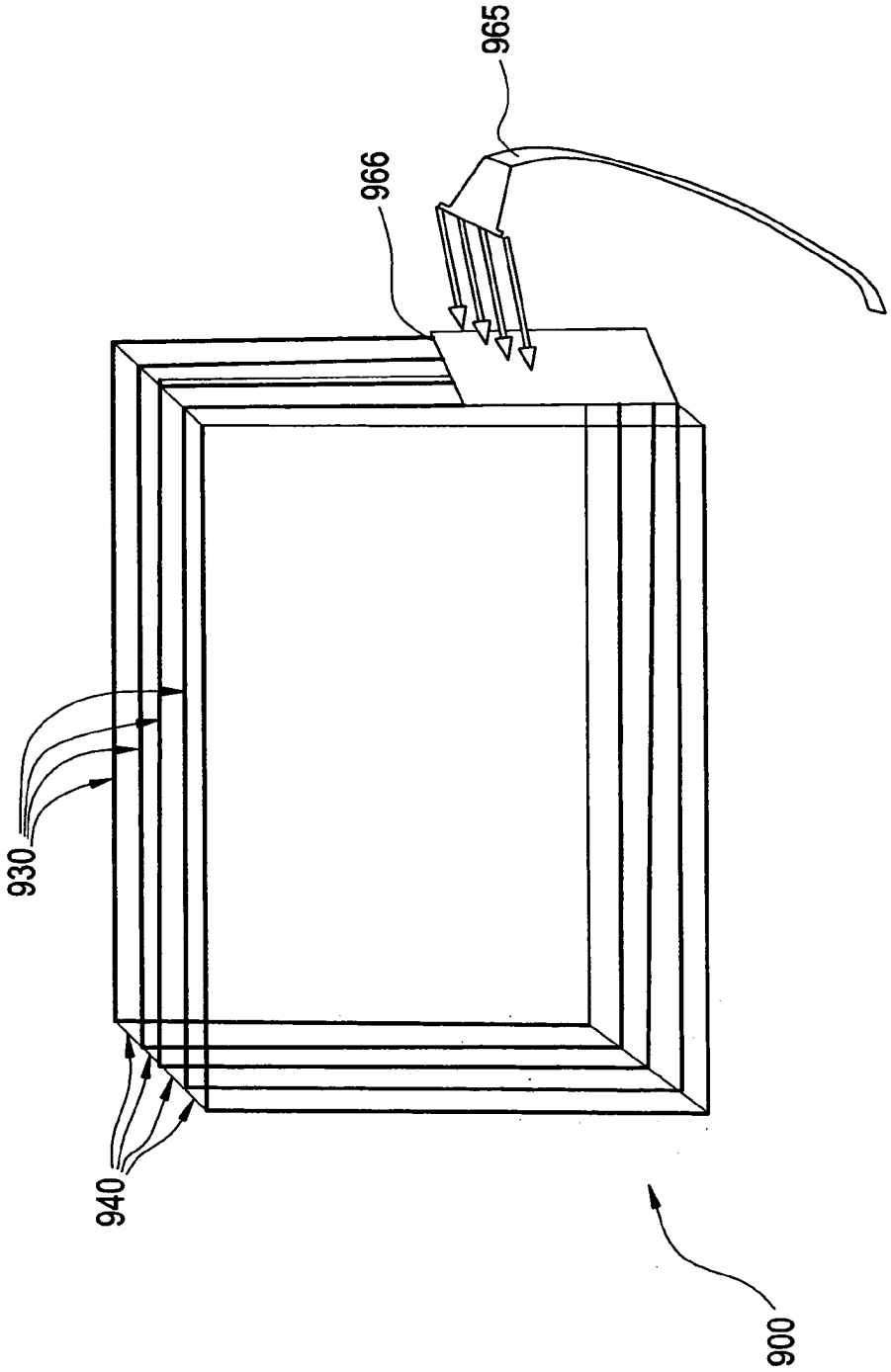


FIG. 9



MULTILAYERED CELL CULTURE APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Application Ser. No. 60/702,896 filed on Jul. 26, 2005 and entitled "Multilayered Cell Culture Apparatus" which is incorporated by reference herein in.

FIELD OF THE INVENTION

The present invention relates generally to the cellular biological field and, in particular, to a cell cultivating flask.

BACKGROUND OF THE INVENTION

In vitro culturing of cells provides material necessary for research in pharmacology, physiology, and toxicology. The environmental conditions created for cultured cells should resemble as closely as possible the conditions experienced by the cells in vivo. One example of a suitable environment for culturing cells is a common laboratory flask such as demonstrated in U.S. Pat. No. 4,770,854 to Lyman. The cells attach to and grow on the bottom wall of the flask, immersed in a suitable sustaining media. The flask is kept in an incubator to maintain it at the proper temperature and atmosphere.

Although most cells will tolerate a hydrogen ion concentration (pH) range of 6.8 to 7.8, the optimal pH for growth of mammalian cells is 7.2 to 7.4. For the optimal pH to be maintained during cell cultivation, the cell culture medium must contain a buffering system.

Frequently, pH is maintained by using a bicarbonate buffering system in the medium, in conjunction with an incubator atmosphere of approximately 5 to 7 percent carbon dioxide by volume. The carbon dioxide reacts with the water to form carbonic acid which in turn interacts with bicarbonate ions in the medium to form a buffering system which maintains the pH near physiological levels. Entry of carbon dioxide from the incubator into the cell culture flask is generally achieved by using a loosely fitting or vented cap or cover so that the small opening remains for the exchange of gas between flask and incubator. Further, flasks have been sold that are made from impact resistant polystyrene plastic which is permeable to water vapor, oxygen and carbon dioxide. However, relying only on the gas exchange through the polystyrene is generally ineffective since the vessel wall thickness greatly decreases the permeability rate. Further still, flasks have been made having a cell growth surface that is itself an extremely thin (approximately 0.004 inches thick) flexible, gas permeable membrane. While this type of construction allows for gas exchange, the flexibility and thinness of the growth surface makes the growth of a uniform surface difficult and contributes to problems associated with the durability of the flask.

Gas exchange, particularly the utilization of oxygen by the cells, is a factor that limits the area for cell growth within a cell culture flask. Since flasks for cell culture typically grow attachment dependent cells in a monolayer roughly equal in size to the footprint of the flask, media volume is therefore restricted to an area within the flask permissive to the diffusion of oxygen. Oxygen and carbon dioxide are of particular importance to the culturing of cells. The supply of oxygen for cellular respiration and metabolic function in conventional cell culture containers occupies the head space of the container, e.g., the void space in the container that is above the surface of the cell culture medium. Thus, the volume of the container and the surfaces within conventional cell culture containers are inefficiently used. This results in limiting the rate of gas exchange and/or restricting the equilibration of gases. There is a need for a cell culture flask that can provide an increased surface area for cell growth while still permitting sufficient gas exchange for the multitude of attachment dependent cells.

Desirably, many flasks are stacked together in the incubator and a number of cultures are simultaneously grown. Small variations in the growth medium, temperature, and cell variability have a pronounced effect on the progress of the cultures. Consequently, repeated microscopic visual inspections are needed to monitor the growth of the cells. As such, cell culture flasks are typically constructed of optically clear material that will allow such visual inspection.

With the advent of cell-based high throughput applications, fully automated cell culture systems have been the subject of serious development work (see e.g. A Review of Cell Culture Automation, M. E. Kempner, R. A. Felder, JALA Volume 7, No. 2, April/May 2002, pp. 56-62.) These automated systems employ traditional cell culture vessels (i.e. common flasks, roller bottles, and cell culture dishes) and invariably require articulated arms to uncap flasks and manipulate them much like the manual operator.

There is a need for a cell culture apparatus having a rigid structure that is capable of providing an increased surface area for cell growth while also providing necessary gas exchange. Even further, it is desirable to produce a greater cell yield within commonly known flask volumes while permitting gas exchange at a surface of cell attachment.

Additionally, the desired cell culture apparatus will be suitable for use in the performance of high throughput assay applications that commonly employ robotic manipulation.

SUMMARY OF THE INVENTION

According to an illustrative embodiment of the present invention, a cell growth apparatus for efficient culturing of cells is disclosed. The illustrative apparatus includes a unitary body including a bottom tray defining a cell growth area and a top plate, connected by side walls and end walls. At least one aperture located along any periphery of the apparatus permits access to the internal volume. At least one gas permeable substrate/membrane is affixed to a support internal to the body of the apparatus. A tracheal space/chamber permits gases from an external atmosphere to be exchanged across the gas permeable, liquid impermeable membrane, into and out of the cell culture chamber(s). Further, the tracheal space is an air chamber confined by an outer vessel body. Communication between a tracheal chamber and a cell growth chamber provides a uniformity of conditions for cellular growth. Furthermore, a uniform gaseous distribution can be beneficial in providing consistency in the culturing environment.

One embodiment of a cell growth apparatus of the present invention includes a plurality of cell growth chambers, each having a gas permeable, liquid impermeable surface and an opposing surface. At least one tracheal chamber is in communication with at least one gas permeable, liquid impermeable surface of a cell growth chamber so that cells can exchange gases (e.g. oxygen, carbon dioxide, etc.) with an external environment. The cell growth apparatus of the present invention has at least one tracheal chamber incorporated with a plurality of cell growth chambers combined into one integral unit. The integral unit thus has multiple growth surfaces in any assembled arrangement. A preferred embodiment of a cell growth apparatus of the present invention alternates each cell growth chamber with a tracheal chamber

in a vertical successive orientation whereby each cell growth chamber includes a substantially planar horizontal surface supporting the growth of attachment-dependent cells. The cell growth surface, however, may be planar and/or nonplanar to accommodate the surface area for growth. A modified or enhanced surface area in combination with one or more tracheal spaces enables a diversified area for growing cells. Subsequently, another embodiment of the present invention may include an arrangement of surfaces intermediary to cell growth surfaces and tracheal spaces. As such, cell growth chambers may be adjoined and configured so that they still have communication with a tracheal chamber.

When a plurality of cell culture chambers are arranged with tracheal chambers formed there-between, the tracheal chambers permit gaseous exchange between the gas permeable, liquid impermeable surface of a cell culture chamber and the external atmosphere. In a preferred embodiment of the present invention, each cell culture chamber alternates with a tracheal chamber allowing the cells greater access to external gaseous exchange.

One embodiment of the apparatus of the present invention utilizes a gas permeable, liquid impermeable membrane as the opposing surface of a cell culture chamber. In such an embodiment, a plurality of gas permeable substrates (internal to the body of the apparatus) can be incorporated to increase surface area for cellular growth. Preferably then, the apparatus is capable of being rotated to facilitate the growth of attachment-dependent cells on an alternate surface. Each gas permeable substrate may have a tracheal space above and/or below it. One such embodiment is capable of incorporating one or more tracheal spaces between each stacked gas permeable substrate/layer. Additionally, the gas permeable membrane(s) may be treated or coated to promote cell growth.

Another embodiment of the present invention includes one or more supports to form a shelf internal to the apparatus. As such, each shelf would have at least one gas permeable substrate affixed. An alternative embodiment may incorporate lateral ribs traversing the flask body such that an internal gas permeable membrane would be further capable of supporting cellular growth. When such supports or lateral ribs are utilized, a plurality of gas permeable membranes can be arranged or housed within the support itself or affixed to one or more surfaces of the supports. It would therefore be important then, when stacking the layers or gas permeable substrates, to include a tracheal space between each, layer of cell growth. Preferably, the tracheal space(s) provide uniform gaseous distribution within the cell culture chamber of the internal apparatus. Completely filling the apparatus with media would allow for optimal cellular nutrient exchange. Consequently, the uniformity of conditions for cellular growth may include a determined media volume per unit surface area. In another aspect, an integral unit of the cell culture apparatus comprises a plurality of modules, each having a cell growth chamber and a tracheal chamber. The plurality of modular gas permeable substrates are utilized to permit a plurality of cell chambers and tracheal chambers to be arranged to form one unitary apparatus of the present invention. The plurality of layers of gas permeable substrates are further capable of being interconnected or adjoined to provide a multiplicity of areas for cellular growth. The plurality of modules may be interconnected in series or staggered to permit continuous flow. For easy assembly and disassembly, individual units having snap-like features could be securely and easily adjoined.

In another embodiment of the present invention, the apparatus comprises a manifold to access the cell growth chambers of an integral unit. The manifold may further be capable of directing the flow of air, liquid, media and/or cellular material within the cell culture chamber.

While many embodiments of the present invention are suitable for static cultures, another embodiment of the present invention staggers the gas permeable substrates within the flask to permit continuous flow through the cell culture chamber. The staggered layers allow media to continuously flow or perfuse through the apparatus.

One embodiment of the present invention provides compliance with conventionally sized and shaped containers currently used such that the apparatus, device or flask of the present invention may be utilized with various equipment and instrumentation. Thus, the apparatus of the present invention may have a substantially rectangular footprint and a substantially uniform height. The rectangular footprint would have dimensions that are substantially identical to an industry standard footprint dimension for microplates. One embodiment of the configuration of the apparatus then may include a neck and/or cap located within the substantially rectangular footprint and that does not exceed the height of the integral unit.

Another embodiment of the apparatus of the present invention may comprise stand-offs either rising from an exterior surface of the top plate or descending from an exterior surface of the bottom tray.

For the addition and removal of media, the cell growth apparatus has at least one access port to access multiple growth chambers. Each cell growth chamber, however, may have individual access ports. Supplementary, the apparatus is capable of being equipped with a septum seal accessible opening or aperture either integrated within the body of the apparatus itself, or as a part of a cap. When a cap is utilized, one embodiment of the apparatus of the present invention, having a height as measured by the distance between an outermost plane of the bottom tray and an outermost plane of the top plate, has a cap, cover, and/or septum covering the aperture. The cap may have a diameter that does not exceed the height of the apparatus/flask so as to prevent interference when the flasks are stacked. Additionally, the cap may be integrally included in a top surface, side, and/or corner region of the apparatus. The apparatus of the present invention may have an aperture which defines an entry portal and another which may define an exit portal. When gas permeable substrates are stacked, the entry and exit portals may be positioned in a parallel or staggered assembly so as to permit flow or perfusion through cell culture chambers within the body of the apparatus.

Convenience then dictates the utilization of one or more optical components, such as microscopic lenses, in communication with individual cell growth chambers. These lenses would allow observation of one or more layers of cell growth. Also, and advantageously so, the apparatus is shaped and configured to enable robotic access to the interior of the apparatus without requiring cumbersome robotic arm manipulation.

The present invention also includes a method of culturing cells in the apparatus of the present invention. The method initially involves providing a apparatus for the growth of cells as previously described. Gas permeable substrates are first assembled into the desired configuration of the apparatus followed by introduction of cells and/or media into the cell culture chamber of the apparatus. Thereafter, the flask can then be incubated to meet the desirable conditions for the growth of cells. Rotation of the apparatus further permits the culturing of cells on an alternate surface of the gas permeable substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is best understood from the following detailed description when read with the accompanying drawing figures. It is emphasized that the various features are not necessarily drawn to scale. In fact, the dimensions may be arbitrarily increased or decreased for clarity of discussion.

FIG. **1**A is a perspective external view of an illustrative embodiment of the apparatus of the present invention.

FIG. **1**B is a cross-sectional perspective side view of an illustrative embodiment of the present invention.

FIG. **1**C is a partial internal side view of intermediary supports and gas permeable growth surfaces of FIG. **1**A.

FIG. **2** is a top view of supports utilized in another embodiment of the present invention.

FIG. **3** is an external top view of a frame supporting a gas permeable membrane in another embodiment of the present invention.

FIG. **4** is a cross-sectional side view of another illustrative embodiment of the present invention.

FIG. **5** is an internal side view of the interconnected chambers of one embodiment of the present invention.

FIG. **5**A is a side view of the external frame/body of the embodiment of FIG. **5**.

FIG. **6** is an individual unit of one embodiment of the present invention.

FIG. **7** is another individual unit or tray of an embodiment of the present invention.

FIG. **8** is an alternative embodiment of the present invention.

FIG. **9** is another embodiment of the present invention.

DETAILED DESCRIPTION

In the following detailed description, for purposes of explanation and not limitation, exemplary embodiments disclosing specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one having ordinary skill in the art that the present invention may be practiced in other embodiments that depart from the specific details disclosed herein. In other instances, detailed descriptions of well-known devices and methods may be omitted so as not to obscure the description of the present invention.

An external view of a apparatus in accordance with one embodiment of the present invention is shown in FIG. **1**. The apparatus **100** of this embodiment takes the form of a flask **100**; the flask **100** comprises an outer vessel body **101** (see FIG. **1**A) defined by a top plate **110**, a bottom tray **120**, sidewalls **112**, and end walls **114**. Disposed within the flask **100** are individual cell growth chambers **111** as can be seen more clearly in a cross-sectional illustration in FIGS. **1**B and **1**C. The individual cell growth chambers **111** are each defined by a generally transparent bottom surface **113** and a generally transparent top surface **115**. The surfaces **113** and **115** are attached to the flask body **101** along the sidewalls **112** and end walls **114**. Preferably, at least one bottom surface **113** within each chamber **111** is gas permeable, liquid impermeable material and capable for the growth of cells **117**. Each top surface **115** is preferably a rigid, generally gas impermeable material (preferably transparent) that will provide support to the cell growth chamber **111**. In this embodiment, supports **119** allow a gas permeable membrane **113** to be securely adhered thereto in a leak-proof sealing to the flask body **101**. Tracheal spaces **118** are created between each cell growth chamber **111**. The opposing top surface **115** of the chamber **111** defines an upper wall to the cell growth chamber **111** as well as a bottom portion of a tracheal chamber **118**. The tracheal chamber **118** is therefore inclusive of a gas permeable, liquid impermeable surface **113** of a first cell growth chamber and an opposing surface **115** to a second growth chamber **111**. Supports **119** further provide structural arrangements to integrally incorporate the surfaces **113** and **115** in forming growth chambers **111** in alternation with tracheal air spaces **118** within the unitary flask **101**. Each cell growth chamber **111** therefore alternates with a tracheal chamber **118** in vertical successive orientation. Accessibility to the cellular growth chambers **111** is achieved via an aperture **120** within the flask body **101**. The aperture **120** having a necked opening **121** is connected to the cell growth chambers **111** via a manifold **104**. The manifold **104** is a portal for manipulation of flask contents. In this embodiment, the necked opening **121** is covered by a cap **122** allowing the flask to be completely filled with media **127** without leakage.

In one embodiment of the present invention, the chambers **111** permit cellular growth on gas permeable membranes **113** such that multiple cell growth chambers **111** are integral with the body **101** of the apparatus **100** and are capable of being completely filled with nutrient media for the growth of cells. The series of tracheal air spaces **118** through the apparatus **100** provide gaseous communication between the cells **117** of the internal volume of the apparatus and the external environment. The tracheal spaces **118** allow oxygenation of media located within cell growth chambers **111** through the gas permeable surfaces **113**. Further, the tracheal chambers **118** may take the form of any air gap or space, and do not allow entrance of liquid. As a result, a rigid cell culture apparatus **100** having multiple growth chambers **111**, alternating with tracheal spaces **118**, is cooperatively constructed to afford the benefit of equivalent gaseous distribution to a large volume of cells **117**. Supplementary, the aperture **120** of the flask is resealable by way of a septum and/or cap **122** to prevent contents of the flask from spilling.

The apparatus **100** of the present invention may be made by any number of acceptable manufacturing methods well known to those of skill in the art. In a preferred method, the apparatus **100** is assembled from a collection of separately injection molded parts. Though any polymer suitable for molding and commonly utilized in the manufacture of laboratory ware may be used, polystyrene is preferred. Although not required, for optical clarity, it is advantageous to maintain a thickness of no greater than 2 mm.

The bottom tray **120** and top plate **110** are preferably injection molded. Various sizes and shapes of the supports **119** may be incorporated to facilitate positioning of the membranous layers **113** for cell culture **117** within the internal flask body **101**. A top view of another embodiment of the present invention (FIG. **2**) has supports **219** as elevated stand-offs **219** along a frame or edge **202** of the flask **100**. The supports **219** are rigid structures to support a sheet of gas permeable membrane **213** adhered to the frame **202**, as well as provide a structural framework to allow multiple layers (rigid or membranous **213**) to be formed within the flask **200**. Alternatively, FIG. **3** illustrates an inner surface **313**, whereby only a portion of each cell growth chamber **300** is gas permeable. For instance, a rigid frame **302** may support a permeable membrane **313**.

Gas permeable, liquid impermeable substrates **113** may be comprised of one or more membranes known in the art. Membranes typically comprise suitable materials that may include for example: polystyrene, polyethylene, polycarbonate, polyolefin, ethylene vinyl acetate, polypropylene, polysulfone, polytetrafluoroethylene (PTFE) or compatible fluoropolymer, a silicone rubber or copolymer, poly(styrene-butadiene-

styrene) or combinations of these materials. As manufacturing and compatibility for the growth of cells permits, various polymeric materials may be utilized. For its known competency, then, polystyrene may be a preferred material for the membrane (of about 0.003 inches in thickness, though various thicknesses are also permissive of cell growth). As such, the membrane may be of any thickness, preferably between about 25 and 250 microns, but ideally between approximately 25 and 125 microns. The membrane **113** allows for the free exchange of gases between the interior of the flask and the external environment and may take any size or shape, so long as the membrane is supportive of cellular growth. A preferred embodiment would include a membrane **113** that is additionally durable for manufacture, handling, and manipulation of the apparatus.

The gas permeable membrane **113** is properly affixed to the supports **119** by any number of methods including but not limited to adhesive or solvent bonding, heat sealing or welding, compression, ultrasonic welding, laser welding and/or any other method commonly used for generating seals between parts. Laser welding around the circumference of the membrane **130** is preferred to establish a hermetic seal around the membrane region such that the membrane is flush with and fused to the face of the supports **132** such it becomes an integral portion of the interior surface of the apparatus. Once the gas permeable membrane **130** is adhered, then the top plate **110** and bottom tray **120** may be joined. The parts are held together and are adhesive bonded along the seam, ultrasonically welded, or laser welded. Preferably, laser welding equipment is utilized in a partially or fully automated assembly system. The top plate and tray are properly aligned while a laser weld is made along the outer periphery of the joint.

Advantageously and in order to enhance cell-attachment and growth, the surfaces internal to the apparatus **100** are treated to enable cell growth. Treatment may be accomplished by any number of methods known in the art which include plasma discharge, corona discharge, gas plasma discharge, ion bombardment, ionizing radiation, and high intensity UV light.

Finally, when a cap **122** is provided, it may be a screw cap, snap-fit cap, cap with septum, cap with air holes, or any cap known in the art. Preferably, a cap **122** is utilized in which a septum is integral with the cap **122**. This will allow a cannula, tip or needle to access the contents of the apparatus **100** without the need for unscrewing. The septum is leak proof, puncturable and capable of resealing once the needle, tip or cannula is removed from the apparatus, even after multiple punctures. In one embodiment, the cap **122** is positioned to access the contents of the apparatus **100** via an end wall **114**. As well, the cap **122** may be positioned on a top surface **110**. Additionally, the cap arrangement can also be located such that the cap **122** does not protrude from the rectangular footprint as determined by the periphery of the apparatus **100**. Other accessibility options may include a neck and cap arrangement within a corner region of the apparatus **100**, such that the cap **122** would not protrude from the periphery of the apparatus body **101**.

In use, the apparatus **100** of the current invention is employed according to accepted cell growth methods. Cells are introduced to the apparatus **100** though the aperture via the neck (or through a septum in the aperture). Along with the cells **117**, media **127** is introduced such that the cells are immersed in the media. The apparatus is arranged such that the cell containing media covers the cell growth surfaces **113**. Advantageously, the apparatus **100** is capable of being completely filled with media since the gas permeable membranes **113** in combination with the tracheal spaces **118** provide uniform gas distribution to the cell growth surfaces **113**. This will further ensure the flow and exchange of gases between flask interior and the external environment. The apparatus is then placed within an incubator and may be stacked together with similar vessels such that a number of cell cultures are simultaneously grown. The apparatus is situated such that the bottom tray **120** assumes a horizontal position (or vertical position depending on the cell culture application). Another advantage of the apparatus **101** of the present invention is its enhanced capacity to grow cells on an opposing surface **115** when the apparatus is rotated 180°. Thus, when the apparatus is rotated, cells can be cultured on an alternate surface **115**. As such, it would be beneficial to have the surface **115** composed of a gas permeable material. Where only gas permeable membranes are layered intermediary to the apparatus, cell growth is therefore enabled on both of its gas permeable surfaces **113/115**.

Cell growth is monitored from time to time by microscopic inspection through the generally transparent interior and exterior surfaces of the apparatus **100**. Easier accessibility and greater visibility of cellular growth can be visualized when optical lenses having varying magnifications are employed in the external body **101**. Additionally, optical lenses may be integrated within other internal surfaces of the apparatus **100**.

Additionally, during the cell growth process, it may become necessary to extract the exhausted media and insert fresh media. As previously described, media replacement may be achieved through insertion of a canula, for example, through the septum. Alternatively, the media may be replaced by removing the cap **122**, in embodiments that offer this option. Once the cells are ready for harvesting, a chemical additive such as trypsin is added to the apparatus through the septum. The trypsin has the effect of releasing the cells from the surfaces of the apparatus. The cells can then be harvested from the flask.

A cap and neck arrangement is not necessary, however, for an apparatus **400** of the present invention (FIG. **4**). As illustrated in this embodiment, supports **432** separate a series of tracheal spaces **440** between each growth layer **450**. The tracheal air spaces provide uniform gas distribution within the flask **400** to each cell culture layer **450**. In this embodiment, the media in the individual cell growth chambers does not mix as these chambers **450** can be considered separate, and possibly, modular units **450** for easy assembly of the apparatus **400**. The chambers **450**, however, may be interconnected via hollow supports **432**. In one embodiment, access to the interior of the apparatus **400** may be accomplished directly, through plugged ports or apertures **460** that are on an end wall **414** to allow accessibility to each cell culture/media layer **450**. Another easy means of access may employ septa as coverings for the apertures **460**.

Septa are capable of being integrally affixed to the body of the apparatus **400** by any of the aforementioned methods for affixing a membrane to the wall of the apparatus. The septa may take any form well known to those of skill in the art including a slit arrangement useful for blunt needles and as generally described in WO 02/066595, the contents of which are incorporated herein by reference. Possible materials that may be employed in making the septa include natural and synthetic elastomeric materials including, but not limited to silicone rubber, fluorocarbon rubber, butyl rubber, polychloroprene rubber, a silicone elastomer composite material, thermoplastic elastomer, medical grades of silicone rubber, polyisoprene, a synthetic isoprene, silicone, santoprene and fluoropolymer laminate and combinations thereof. In a preferred embodiment, the elastomeric material is substantially

nontoxic to cultured cells. Moreover, a universal septum may cover each aperture **460** while still allowing access to each individual layer of cell growth **450**. This embodiment of the flask **400** may be preferred when stacking of the apparatus **400** is required, or when significant robotic manipulation is encountered since it eliminates the need for cap displacement.

FIGS. **5** and **5**A illustrate another embodiment of the present invention. As illustrated in partial internal and external cross-sectional views, respectively, a multilayered culture vessel **501** of the present invention is a perfusion system **500**. Multiple gas permeable substrates **530** are adhered to supports/frames **532** and stacked in a parallel configuration permitting an airway or tracheal space **540** to separate each cellular growth layer **550**. As in previous embodiments, the gas permeable substrates/membranes **530** in combination with the tracheal chambers **540** define the cell culture system **500**. The tracheal spaces **540**, alternating with layers of transparent gas permeable membrane(s) **530** and supports **532**, provide air/gas exchange with media and cell cultures **550** on an alternate or opposing surface of the gas permeable substrate **530**. As such, liquid media inside the apparatus **501** is capable of being contained within a layer **550**. In addition, the tracheal air chambers **540** under each cell growth surface **550** have gaseous communication between the cells/media layers **550** and external environment via the series of openings **541** formed between the supports **532** in the external apparatus body **501**. The necked opening **560** comprises one aperture which defines an entry portal **562** and one aperture which defines an exit portal **564**. The entry portal **566** and exit portal **568** in conjunction with the necked opening **560** allows access to the internal volume/layers **550** of the apparatus **500**. Furthermore, in this embodiment of the apparatus/vessel **501**, a raised rim **580** serving as a standoff **580** is located on the surfaces of both the top plate **510** and bottom plate **520**. The standoff rim **580** is intended to contact the bottom tray **520** of an identical vessel that is stacked on top the apparatus **501**. Stacking makes efficient use of incubator space. Another attribute of having a standoff rim **580** is the allowance of an air gap between stacked flasks; the air gap is important for allowing gas exchange through any vent that may be incorporated into an upper or underside surface of the apparatus **501**, and further prevents damage to the gas permeable membrane **530**. Other alternatives for standoffs **580** include raised corners, posts, ledges, or any other feature that will allow spacing between successively stacked flasks. Preferably, the bottom plate **520** is molded with a rim **580** around the periphery that can engage with a standoff rim **580** from an immediately adjacent apparatus to ensure lateral stability of the stacked vessels.

For exemplary purposes and not limitation, cell seedlings, media exchange, and/or cell harvesting can be accessed via the entry portal(s) **566** and exit portal(s) **568**. In combination with the portals **566**/**568**, linear fluid flow restrictors **564** can act as manifolds to evenly direct flow during cell harvesting. Additionally, for exemplary purposes only and not limitation, an embodiment of the present invention incorporates a staggered configuration of gas permeable substrates **530** in conjunction with the supports **532** so as to allow continuous flow or perfusion through the vessel **501**. Various arrangements of the layers **550** and stacked substrates **530**, however, would permit utilization of the vessel **501** for static cell culture or cell culture in a perfusion system as discussed, including parallel, symmetrical, or asymmetrical arrangements.

For easier accessibility and manufacturing of the multilayered apparatus **501**, the arrangement of cell growth layers **550** and stacked substrates **530** into individual modular units may be preferred. As such, a modular unit of one embodiment of the present invention is illustrated in FIG. **6**. An individual modular unit **600** comprises a support network **632** in combination with gas permeable membranes/substrates **630**. A plurality of modular units **600** are capable of being interconnected and/or interlocked or adhered together to provide a multiplicity of growth surfaces **630**/**631** that can be easily assembled or disassembled into a unitary multilayered vessel for cellular culture. Vertical stacking of the modular units **600** would be analogous to interconnecting building blocks. Any number of cell growth layers **600** could be assembled or disassembled to provide a wide range of accessibility options to each modular cell growth unit **600**. One embodiment of the present invention utilizes supports **632** forming a shelf/frame **633** along a periphery of the individual unit **600** in addition to lateral ribs **635** spanning or bisecting the distance internal to the frame **633**. The transparent gas permeable substrate(s) **630** are adhered to supports **632** such that air gaps or tracheal spaces **640** are formed between each cell layer of gas permeable substrate **630** to allow gas distribution throughout the unitary apparatus when multiple trays are assembled into one vessel body. The tracheal spaces **640** have gaseous exchange with the external atmosphere via the tracheal openings/ports **641** in the external frame **633**. Further, the tracheal spaces **640** provide air/gas exchange with media and cell cultures on a [primary] surface **630** and an alternate or secondary surface **631**, both surfaces **630**/**631** capable of cell growth. As seen in this embodiment, peripheral ridges or elevations **637** of the support system **632** are utilized to facilitate stacking of the modular units **600**. The gas permeable membrane **630**, however, may be adhered to any of the surfaces of the support system **632** or peripheral edge **637** so as to provide a leak-proof gas permeable substrate **630** in combination with the modular unit **600** and further permitting multiple areas for cell growth on the gas permeable surfaces **630**/**631**. Additionally, an open end **633** of the frame **632** is a feature to permit fluid flow when multiple modular units **600** are stacked and adhered together into a unitary body so as to be utilized in perfusion devices. Furthermore, one embodiment of the apparatus of the present invention encompasses one gas permeable substrate **630** providing a primary growth surface **630**, as well as an [optional] gas permeable substrate **631** providing a secondary growth surface **631** adhered to an underside of the frame network **632**.

As seen in FIG. **7**, another embodiment of the present invention utilizes a modular unit **700** inclusive of a cap **762** covering an aperture **760**. A manifold **764** permits access to the internal cell culture layer **750**. A unitary cell culture chamber is capable of being constructed when individual units **600** and/or **700** are stacked. Further, when combined, the internal cell culture layers **650** and/or **750** would be accessible via the aperture **760** to the unitary cell culture chamber.

In utilizing the vessels of the current invention, various methods in the industry may be employed in accordance with accepted cell growth culturing. As discussed in a previous embodiment, cells are introduced to the flask though the neck or through the septum. Along with the cells, media is introduced such that the cells are immersed in the media. The apparatus is arranged such that the cell-containing media covers the cell growth surfaces. Advantageously, the apparatus is capable of being completely filled with media since the gas permeable membranes in combination with the tracheal spaces provide uniform gas distribution to the cell growth surfaces. This will furthermore ensure the flow and exchange of gases between flask interior and the external environment. The apparatus is then placed within an incubator and may be stacked together with similar flasks such that a number of cell cultures are simultaneously grown. The flask is situated such

that the bottom tray assumes a horizontal position (or vertical position depending on the cell culture application). The flask can then be rotated to permit the culturing of cells on an alternate surface. Where only gas permeable membranes are layered intermediary to the apparatus, cell growth is enabled on upper and under sides of the membrane (opposing gas permeable surfaces).

Cell growth can be monitored from time to time by microscopic inspection through the generally transparent surfaces. If more detailed visual inspection of the cell growth layers is required, optical lenses can be integrated into the body or frame of the apparatus. As such, varying magnifications of the optical lenses would permit viewing within individual layers without disassembly of the apparatus. Optical lenses may be incorporated into any surface or modular unit, as well, preferably when the units are capable of being disassembled for observational analysis.

During the cell growth process, it may become necessary to extract the exhausted media and insert fresh media. As previously described, media replacement may be achieved through insertion of a canula, for example, through the septum. Alternatively, the media may be replaced by removing the cap, in embodiments that offer this option. Once the cells are ready for harvesting, a chemical additive such as trypsin is added to the flask through the septum. The trypsin has the effect of releasing the cells from the vessel surfaces. The cells are then harvested from the apparatus.

As discussed, the embodiments of the present invention are for exemplary purposes only and not limitation. Supplementary, tracheal spaces are capable of being formed above and/or below the support network when the trays are stacked upon one another where peripheral ridges of individual modular units permit gaps of air to flow through gas permeable substrates to cell growth areas when the units are interconnected. The tracheal spaces formed within the individual units are further capable of including a diversified network of supports, intersecting and/or alternating gas permeable membrane with supports and air/tracheal spaces.

The gas permeable substrates utilized in the embodiments of the present invention are capable of cell growth and gas exchange with the external environment, achieving uniform gaseous distribution throughout the cell culture vessel. Furthermore, the apparatus of the present invention may utilize horizontal or vertical designs having surfaces arranged for uniform gaseous distribution to cell growth areas. As seen in one embodiment of the present invention in FIG. **8**, vertical growth surfaces or gas permeable substrates **830** are separated by tracheal spaces **840**. The tracheal spaces **840** allow for the exchange of oxygen, carbon dioxide, and other various gases between the respiratory/gas permeable surfaces **830** that the cells grow on and the incubator or external atmosphere where the apparatus **800** is stored while the cells are given time to grow. The apparatus **800** of the present invention may include a cap **862** and/or a manifold **864**, as well, which is unitary with the vessel body **800**.

Another embodiment of the present invention (FIG. **9**) is an apparatus **900** that includes an external manifold **965** allowing access to individual cell growth layers **930** via a septum as discussed previously. The units **930** are modular and joined together to handle as one. Furthermore, tracheal spaces **940** allow uniform gaseous distribution to cell growth areas **930** throughout the flask **900**. The uniformity of conditions for cellular growth may include a determined media volume per unit surface area. Though the determined ratio of volume per unit surface area has previously been known within a confined range of about 0.5-1.0 ml/cm^2, the ratio is no longer limiting due to the direct access of the cells to gaseous exchange via the gas permeable membrane upon which the cells grow. While efficient use of media is still preferable, any volume of media may be utilized in an apparatus of this invention, the apparatus of which may be any size and/or take any shape. Further, the enhanced capabilities of the present invention may incorporate tracheal spaces in combination with cell growth chambers into standardized or conventionally-sized containers. One embodiment of the apparatus of the present invention includes an increased surface area for cellular growth preferably with a ratio of media volume per unit surface area in the range of about 0.25-0.50 ml/cm^2; however, the dimensions and confines for cellular growth are unlimited. One such embodiment would include a height of about 2.8 mm. As stated previously, however, the height is unrestricted so long as it permits area for the growth of cells. Furthermore, by completely filling the cell growth chambers with media, the cells have access to optimal nutrient exchange.

The embodiments of the present invention may be modified to take the shape of any device, container, apparatus, vessel, or flask currently used in industry. Specifically, cylindrical or alternative vessels may utilize gas permeable substrates (internal to the vessel) in combination with tracheal chambers or spaces to provide an improved culturing environment for the growth of cells. A spiral or alternative approach inclusive of a tracheal chamber would therefore be possible. Further, although tracheal chambers may take many forms and be of any size, the passageway-like chambers are: a) confined air spaces, b) in communication with a gas permeable membrane that is permissive to cell growth, and c) communicative with the external environment via open direct access and/or additional gas permeable membranes.

As presented, the multiple embodiments of the present invention offer several improvements over standard vessels currently used in industry. The improved cell culture devices remarkably enhance the volume of cells that are capable of being cultured in the volume enclosed by traditional cell culture vessels. The various benefits are attributable to the multi-layered arrangement of gas permeable membranes assembled into a unitary vessel. Successive layering of individual growth chambers and tracheal chambers inclusive of the gas permeable membranes makes oxygen and other gases from the external environment available to the internal contents of the apparatus. Specifically, gaseous exchange with the nutrient media is conducive to an even distribution of cell growth when gas permeable membranes are utilized on at least one potential growth surface. The cell growth apparatus is capable of fully utilizing its capacity by allowing cells access to optimal volumes of nutrient media and direct oxygenation via the tracheal spaces. Additional benefits are afforded to the cell culturing apparatus in which the exterior framework is rigidly constructed, conveniently offering easy handling, storage, and accessibility.

In one embodiment, the present invention has a footprint conforming to industry standard for microplates (5.030+/−0.010 inches by 3.365+/−0.010 inches). For this reason, the neck portion is preferably recessed within the overall rectangular footprint. The advantage of providing an apparatus with such a footprint is that automated equipment designed specifically for the manipulation of microplates may be utilized with this apparatus with very little customized modification. Similarly the height, or the distance between the outer most portion of the bottom tray and the outer portion of the top plate, is approximately 0.685+/−0.010 inches. At any rate, the present invention is not intended to be limited in any way by the aforementioned preferred dimensions and in fact may be constructed to any dimension.

As exemplified, the apparatus may include any unitary structure, vessel, device or flask with the capacity to integrally incorporate substrates in successive orientation. The invention being thus described, it would be obvious that the same may be varied in many ways by one of ordinary skill in the art having had the benefit of the present disclosure. Such variations are not regarded as a departure from the spirit and scope of the invention, and such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims and their legal equivalents.

The invention claimed is:

1. A cell growth apparatus comprising:

a plurality of cell growth chambers, each having a gas permeable, liquid impermeable membrane, an opposing surface, and at least one side wall connected to at least one of the gas permeable, liquid impermeable membrane and the opposing surface; and

at least one tracheal space in communication with at least one gas permeable, liquid impermeable membrane of at least one cell growth chamber;

wherein the at least one tracheal space comprises peripheral supports on a peripheral edge of the tracheal space;

wherein the supports on the peripheral edge of the tracheal space are spaced apart to create a plurality of gaps to allow gasses to flow from an external environment into the tracheal space through the plurality of gaps between peripheral supports.

2. The apparatus of claim **1**, wherein said at least one tracheal space and said plurality of cell growth chambers are combined into at least one integral unit.

3. The apparatus of claim **2**, wherein each cell growth chamber alternates with said tracheal space in successive orientation.

4. The apparatus of claim **3**, whereby said cell growth chambers are adjoined with and are in gaseous communication with said at least one tracheal space through the gas permeable, liquid impermeable membrane.

5. The apparatus of claim **2**, said integral unit having at least one access port to each cell growth chamber.

6. The apparatus of claim **5**, wherein at least one access port includes a neck.

7. The apparatus of claim **2**, further comprising a manifold to access said plurality of cell growth chambers.

8. The apparatus of claim **2**, wherein said cell growth chambers are structured and arranged to completely fill with media for optimal cell-nutrient exchange.

9. The apparatus of claim **2**, wherein said opposing surface is gas permeable, liquid impermeable membrane.

10. The apparatus of claim **2**, wherein one or more optical components are in communication with said cell growth chamber(s).

11. The apparatus of claim **2**, whereby said integral unit comprises a plurality of modules.

12. The apparatus of claim **11**, wherein said plurality of modules are interconnected in series or staggered to permit continuous flow.

13. The apparatus of claim **2**, wherein said integral unit has a substantially rectangular footprint and a substantially uniform height.

14. The apparatus of claim **13**, wherein a neck anti/or cap is located within said substantially rectangular footprint and does not exceed the height of said integral unit.

15. The apparatus of claim **2**, further comprising stand-offs rising from an exterior surface of a top plate of the apparatus, descending from an exterior surface of a bottom tray of the apparatus, or both.

16. A cell growth apparatus comprising:

at least one cell growth chamber having a gas permeable, liquid impermeable membrane, an opposing surface, and at least one side wall connected to at least one of the gas permeable, liquid impermeable membrane and the opposing surface;

at least one tracheal space in communication with at least one gas permeable, liquid impermeable membrane of the at least one cell growth chamber;

wherein the at least one tracheal space comprises peripheral supports on a peripheral edge of the tracheal space to support the gas permeable, liquid impermeable membrane;

wherein the supports on the peripheral edge of the tracheal space are spaced apart to create a plurality of gaps to allow gasses to flow from an external environment into the tracheal space through the plurality of gaps between peripheral supports; and

wherein the at least one tracheal space is an air space in communication with the external environment.

17. The apparatus of claim **15**, wherein said at least one tracheal space and said plurality of cell growth chambers are combined into at least one integral unit.

18. The apparatus of claim **17**, wherein each said cell growth chamber alternates with said tracheal space in successive orientation.

19. The apparatus of claim **17**, whereby said cell growth chambers are adjoined and are in communication with said tracheal space.

20. The apparatus of claim **16**, wherein said tracheal spaces permit gaseous exchange between said gas permeable, liquid impermeable surface of said cell culture chamber and the external environment.

21. The apparatus of claim **17**, said integral unit comprising at least one access port to each cell growth chamber.

22. The apparatus of claim **21**, wherein at least one access port comprises a neck.

23. The apparatus of claim **16**, further comprising a manifold to access said plurality of cell growth chambers.

24. The apparatus of claim **16**, wherein said cell growth chambers are structured and arranged to completely fill with media for optimal cell-nutrient exchange.

25. The apparatus of claim **16**, further comprising at least one access port to each cell growth chamber.

26. The apparatus of claim **25**, wherein at least one access port comprises a neck.

27. The apparatus of claim **25**, further comprising a manifold to access said plurality of cell growth chambers.

28. The apparatus of claim **16**, wherein said opposing surface is gas permeable, liquid impermeable membrane.

29. The apparatus of claim **16**, wherein one or more optical components are in communication with said cell growth chamber(s).

30. The apparatus of claim **17**, wherein said integral unit comprises a plurality of modules.

31. The apparatus of claim **30**, wherein said plurality of modules are interconnected in series or staggered to permit continuous flow.

32. The apparatus of claim **16**, wherein said integral unit has a substantially rectangular footprint and a substantially uniform height.

33. The apparatus of claim **32**, wherein a neck or a cap is located within said substantially rectangular footprint and does not exceed the height of said integral unit.

34. The apparatus of claim **16**, further comprising stand-offs rising from an exterior surface of a top plate and/or descending from an exterior surface of a bottom tray.

35. The apparatus of claim **1** further comprising internal supports internal to the peripheral edge of the tracheal space to support the gas permeable, liquid impermeable membrane.

36. The apparatus of claim **35** wherein the internal supports are spaced apart to create a plurality of gaps to allow gasses to flow in the tracheal space through the plurality of gaps between internal supports.

37. The apparatus of claim **35** wherein the internal supports comprise lateral ribs.

38. The apparatus of claim **16** further comprising internal supports internal to the peripheral edge of the tracheal space to support the gas permeable, liquid impermeable membrane.

39. The apparatus of claim **35** wherein the internal supports are spaced apart to create a plurality of gaps to allow gasses to flow in the tracheal space through the plurality of gaps between internal supports.

40. The apparatus of claim **38** wherein the internal supports comprise lateral ribs.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,745,209 B2
APPLICATION NO. : 11/433859
DATED : June 29, 2010
INVENTOR(S) : Gregory Roger Martin et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Col.	*Line*	*Description*
13	49	Reads "is gas permeable, liquid impermeable membrane." Should read "is gas permeable, liquid impermeable."
13	61	Reads "The apparatus of claim 13, wherein a neck anti/or cap is" Should read "The apparatus of claim 13, wherein a neck and/or cap is"
13	65	Reads "rising from an exterior surface of a top plate of the apparatus," Should read "rising from an exterior surface of a top plate,"
14	20	Reads "The apparatus of claim 15, wherein said at least one" Should read "The apparatus of claim 16, wherein said at least one"

Signed and Sealed this
Sixteenth Day of August, 2011

David J. Kappos

David J. Kappos
Director of the United States Patent and Trademark Office

US008178345B2

(12) **United States Patent**
Bennett et al.

(10) **Patent No.: US 8,178,345 B2**
(45) **Date of Patent: May 15, 2012**

(54) **MULTILAYER CELL CULTURE VESSELS**

(75) Inventors: **Scott M. Bennett**, Limerick, ME (US); **Henry J. Cattadoris**, Scarborough, ME (US); **David A. Kenney**, Lunenburg, MA (US); **Gregory R. Martin**, Acton, ME (US); **Allison J. Tanner**, Portsmouth, NH (US); **Joseph C. Wall**, Southborough, MA (US)

(73) Assignee: **Corning Incorporated**, Corning, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 282 days.

(21) Appl. No.: **12/211,378**

(22) Filed: **Sep. 16, 2008**

(65) **Prior Publication Data**

US 2009/0298163 A1 Dec. 3, 2009

Related U.S. Application Data

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(51) **Int. Cl.**
C12M 1/24 (2006.01)
C12M 1/00 (2006.01)
C12M 1/14 (2006.01)

(52) **U.S. Cl.** **435/304.2**; 435/289.1; 435/299.1; 435/299.2; 435/304.1; 435/304.3

(58) **Field of Classification Search** 435/340.2, 435/289.1–309.4
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,042,108	A *	8/1977	Brethauer	206/392
4,770,854	A	9/1988	Lyman	422/102
5,763,267	A	6/1998	Kurjan et al.	435/293.1
2007/0026516	A1	2/2007	Martin et al.	435/297.5
2008/0003671	A1 *	1/2008	Martin	435/304.1
2008/0206857	A1 *	8/2008	Kenney et al.	435/300.1

* cited by examiner

Primary Examiner — Nathan Bowers
Assistant Examiner — Gautam Prakash
(74) *Attorney, Agent, or Firm* — Susan S. Wilks

(57) **ABSTRACT**

A multilayered cell culture apparatus for the culturing of cells is disclosed. The cell culture apparatus includes a unitary flask body including a rigid upper and lower surface, connected by side walls. The cell growth apparatus comprises multiple cell growth chambers stacked in vertical alignment and orientation within the unitary flask body. The stacked chambers are held in position by unitary connecting columns that run through each cell growth chamber and terminate at the rigid upper and lower surfaces of the apparatus. The cell growth chambers are separated by tracheal spaces that allow air from the external environment to contact the cell growth surface of each individual cell growth chamber.

17 Claims, 2 Drawing Sheets

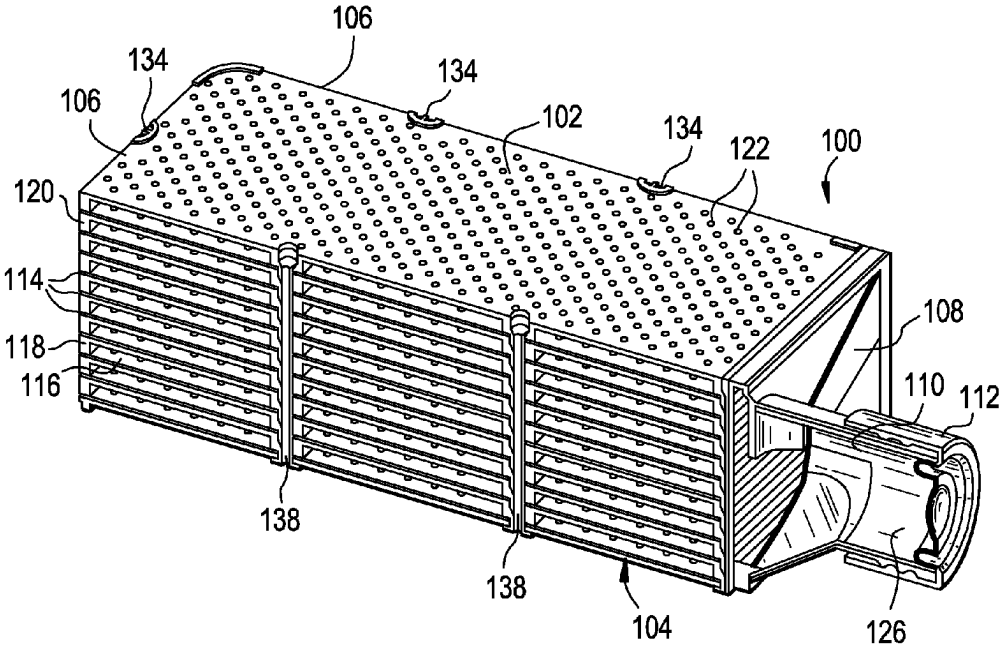
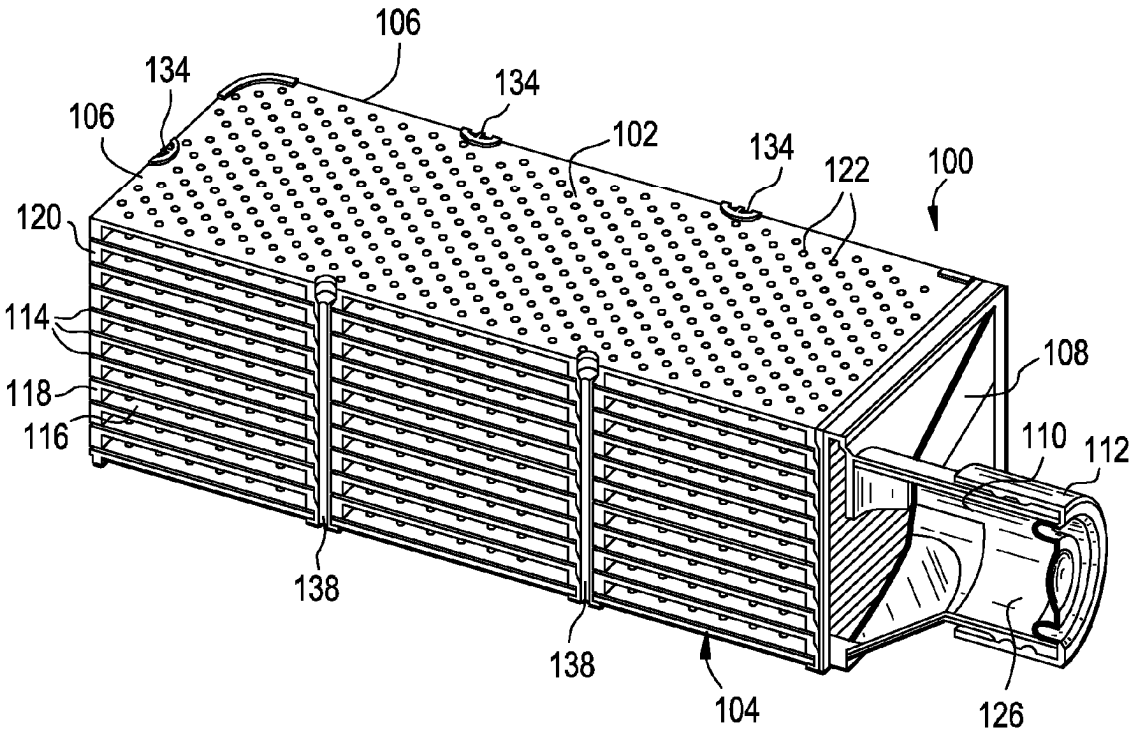


FIG. 1


106
134
134
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102
134
122
100
120
114
108
118
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112
116
138
138
104
126

FIG. 2

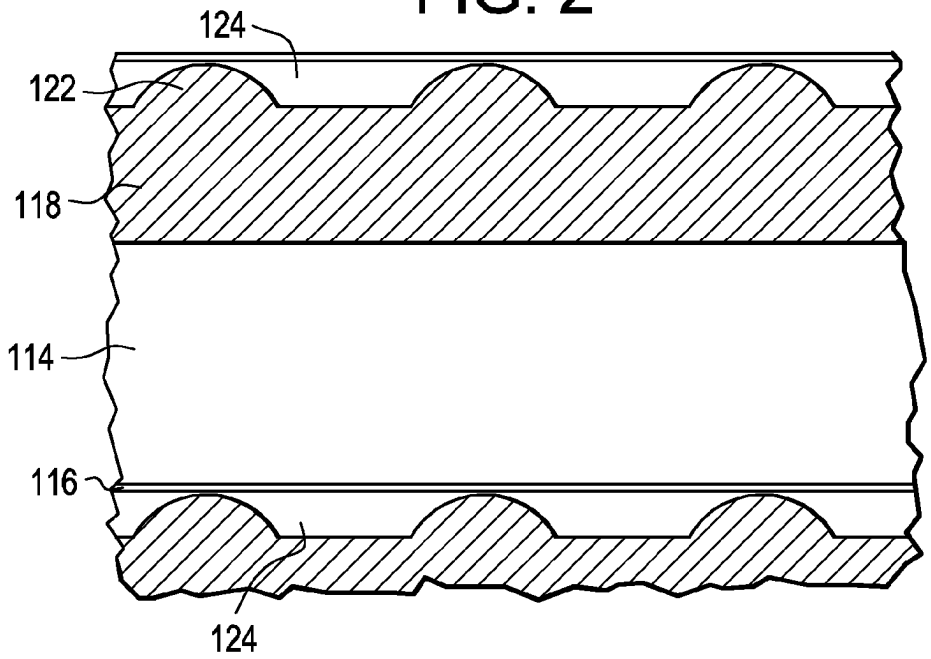
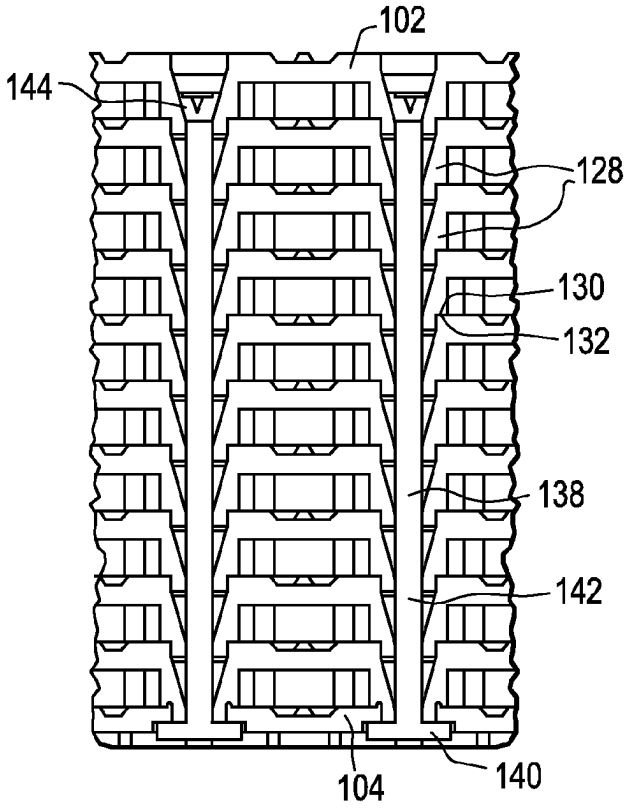


FIG. 3



MULTILAYER CELL CULTURE VESSELS

CLAIMING BENEFIT OF PRIOR FILED U.S. APPLICATION

This application claims the benefit of U.S. Provisional Application Ser. No. 61/130,522, filed on May 30, 2008. The content of this document and the entire disclosure of publications, patents, and patent documents mentioned herein are incorporated by reference.

FIELD OF THE INVENTION

The present invention relates generally to the cellular biological field and, in particular, to a cell cultivating flask.

BACKGROUND OF THE INVENTION

In vitro culturing of cells provides material necessary for research in pharmacology, physiology, and toxicology. The environmental conditions created for cultured cells should resemble as closely as possible the conditions experienced by the cells in vivo. One example of a suitable environment for culturing cells is a common laboratory flask such as demonstrated in U.S. Pat. No. 4,770,854 to Lyman. The cells attach to and grow on the bottom wall of the flask, immersed in a suitable sustaining media. The flask is kept in an incubator to maintain it at the proper temperature and atmosphere.

Gas exchange, particularly the utilization of oxygen by the cells, is a factor that limits the area for cell growth within a cell culture flask. Since flasks for cell culture typically grow attachment dependent cells in a monolayer roughly equal in size to the footprint of the flask, media volume is restricted to an area within the flask permissive to the diffusion of oxygen. Oxygen and carbon dioxide are of particular importance to the culturing of cells. The supply of oxygen for cellular respiration and metabolic function in conventional cell culture containers occupies the head space of the container, e.g., the void space in the container that is above the surface of the cell culture medium. Thus, the volume of the container and the surfaces within conventional cell culture containers are inefficiently used. This results in limiting the rate of gas exchange and/or restricting the equilibration of gases.

The need for large quantities of cells for high throughput screening (HTS) cell based assays continues to motivate organizations to search for methods to achieve larger cell numbers with minimal investment. The challenge is to generate large quantities of cells that all behave the same in cell based assays. In order to provide a solution it is imperative that the cells generated using such methods exhibit similar characteristics such as growth kinetics and response to stimuli. The multilayer flask that is the subject of commonly assigned patent application US 20070026516, incorporated in its entirety herein by reference, describes using several successive layers of cell growth chambers within a unitary vessel, each individual chamber having a gas permeable film and separated from the next by a tracheal space to provide gas exchange between the cells and culture medium and the atmospheric environment surrounding it. This allows for an expansive cell growth surface area when compared to standard traditional flasks such as the industry standard T175 flask. The HYPERFLASK (Corning Incorporated, Corning, N.Y.) vessel has roughly the same dimensions of the industry standard T175 flask (a flask body of approximately 157 mm×122 mm×53 mm) but was developed to generate approximately 10 times as many cells due to the 10 cell growth chambers

housed within the flask body. A single HYPERFLASK vessel can be used to seed as many as 100 384 well microplates.

In a commercial embodiment of the HYPERFLASK product, each of the layers or individual cell growth chambers are held together by welds around the perimeter of the flask and press fit to each other in the center such as to form two press fit columns. Under certain conditions of use, pressure can build such that the press fit features cannot hold, and the columns separate leading to potential leaks in the vessel.

SUMMARY OF THE INVENTION

According to an illustrative embodiment of the present invention, a cell growth apparatus for efficient culturing of cells is disclosed. The apparatus includes a unitary flask body including a rigid upper and lower surface, connected by side walls. In one embodiment, the cell growth apparatus comprises multiple cell growth chambers stacked in vertical alignment and orientation within the unitary flask body. The stacked chambers are held in position by unitary connecting columns that run through each cell growth chamber and terminate at the rigid upper and lower surfaces. In one embodiment, the cell growth chambers are separated by tracheal spaces that allow air from the external environment to contact a growth surface of each cell growth chamber.

In another embodiment, a first cell culture chamber is formed by a first top surface, an opposing first bottom surface spaced apart from the first top surface, and a first sidewall around the first chamber and extending between the first top surface and the first bottom surface. A second cell culture chamber is formed by a second top surface, an opposing second bottom surface spaced apart from the second top surface, and a second sidewall around the second chamber and extending between the second top surface and the second bottom surface. The cell culture chambers are held together by at least one unitary connecting column running continuously through the surfaces orthogonal to a plane created by the surfaces.

In yet another embodiment, the first and second chambers are disposed in a stacked arrangement such that the first and second sidewalls are substantially aligned and the first bottom surface is proximate the second top surface, and the first bottom surface and second top surface are spaced apart to form a tracheal space that is in fluid communication with the external environment thereby allowing free gas exchange through the gas permeable, liquid impermeable cell growth bottom surface of each cell growth chamber.

In one embodiment, the lower surface of the cell growth apparatus is a rigid planar piece that is spaced away from the second bottom surface but contacting the second sidewall along a periphery and wherein the cell culture chambers are combined into the integral flask unit.

In another embodiment, the apparatus further contains internal bosses defined by walls connecting each respective top and bottom surface whereby the walls having an inner and outer surface. In one embodiment, the bosses take the form of truncated cones, the diameter at the top of which is larger than the diameter at the bottom. Further, the bosses may contain a top and bottom portion and a step feature on the outer wall of the boss proximate to the bottom portion for fittingly engaging the inner wall of the top portion of a boss from a cell growth chamber immediately below, in such a way that when the bosses are fittingly engaged, the inner walls of the bosses define a cavity through the cell growth chambers. This cavity can be filled with the connecting column to hold all cell growth chambers together. Optionally, the connecting column further comprises a flattened head portion and an elon-

gated pin portion, the flattened head portion engages the rigid lower surface which the terminal end of the pin portion can be melted and fixedly joined to an upper surface of the flask body. In another embodiment, there are a plurality of additional cell growth chambers stacked in succession above the first and second cell growth chambers, each additional cell culture chamber having a top surface, an opposing bottom surface spaced apart from the first top surface, and a sidewall around the chamber and extending between the top surface and the bottom surface, and wherein the connecting column further extends through the surfaces of each additional cell culture chamber thereby connecting the first, second and each additional cell culture chamber. In one embodiment, the dimensions of the flask are substantially identical to that of the industry standard T175 flask.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is best understood from the following detailed description when read with the accompanying figures. It is emphasized that the various features are not necessarily drawn to scale. In fact, the dimensions may be arbitrarily increased or decreased for clarity of discussion.

FIG. **1** is a perspective view of an illustrative embodiment of the cell growth apparatus of the present invention in cross section. The section line runs along the bi-symmetrical central axis of the apparatus.

FIG. **2** is a cross-sectional partial view of the cell growth apparatus of FIG. **1** illustrating an individual cell growth chamber.

FIG. **3** is a partial and compressed cross sectional view of the cell growth apparatus of FIG. **1**.

DETAILED DESCRIPTION

In the following detailed description, for purposes of explanation and not limitation, exemplary embodiments disclosing specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one having ordinary skill in the art that the present invention may be practiced in other embodiments that depart from the specific details disclosed herein. In other instances, detailed descriptions of well-known devices and methods may be omitted so as not to obscure the description of the present invention.

In accordance with one embodiment of the present invention, a perspective view in cross section of a cell growth apparatus is shown in FIG. **1**. The cell growth apparatus **100** of this embodiment takes the form of a flask **100**; the flask **100** comprises a rigid upper surface **102** and rigid lower surface **104** surrounded by sidewalls **106**, a manifold **108**, a threaded neck **110** and a cap **112**. In one embodiment, a plurality of individual cell growth chambers **114** are disposed within the internal volume of the flask. The individual cell growth chambers **114** are each defined by a generally transparent bottom surface **116** and a generally transparent top surface **118**. The surfaces **116** and **118** are attached to the flask body along the sidewalls **106**. In one embodiment, the bottom surfaces **116** within each chamber **114** are made from gas permeable, liquid impermeable material that is capable of supporting cell growth. In one embodiment, each top surface **118** is a rigid, generally gas impermeable material (preferably transparent) that will provide support to the cell growth chamber **114**. The top surface **118** includes descending end walls that contact and seal with the bottom surface **116** along their periphery. On the uppermost surface of the top surface **118**, spacers **122** in the form of half spherical beads provide structural support for the bottom surface of the cell culture chamber immediately above. As shown in a partial cross sectional view of FIG. **2**, tracheal spaces **124**, are created between each cell growth chamber **114** by stand-offs descending from the sidewalls of each cell growth chamber. The opposing top surface **118** of each chamber **114** defines a top surface of a cell growth chamber **114** as well as a bottom portion of a tracheal space **124**. Each cell growth chamber **114** therefore alternates with a tracheal space **124** in vertical successive orientation. Although the cell growth chamber may have any sized head space or height, in one embodiment, the height of the individual cell growth chambers is between 0.1 and 0.2 inches. Side portals created between the stand-offs in the side wall of the cell growth apparatus allow air to circulate through the tracheal chambers **124** for gas exchange with the external environment via the gas permeable bottom surfaces **116**. Accessibility to the cellular growth chambers **114** is achieved via an aperture **126** within the flask body. The aperture **126** has a neck **110** and is connected to the cell growth chambers **114** via the manifold **108**.

In one embodiment of the present invention, the chambers **114** permit cellular growth on gas permeable membranes **116** such that multiple cell growth chambers **114** are integral with the body of the apparatus **100** and are capable of being completely filled with nutrient media for the growth of cells. The series of tracheal spaces **124** through the apparatus **100** provide gaseous communication between the cells located within each cell growth chamber **114** and the external environment. The tracheal spaces **124** allow oxygenation of media located within cell growth chambers **114** through the gas permeable bottom surfaces **116**. Further, the tracheal spaces **124** may take the form of any air gap or space that will not allow entrance of liquid. The tracheal spaces are formed by multiple spaced stand-offs descending from the sidewalls of each individual cell growth chamber, the height of which will create spacing for air exchange. As a result, a rigid cell culture apparatus **100** having multiple growth chambers **114**, alternating with tracheal spaces **124**, is constructed to afford the benefit of equivalent gaseous distribution to a large volume of cells. The aperture **126** of the flask is sealable by way of a septum and/or cap **112** to prevent contents of the flask from spilling. Typical height for the tracheal space is between 0.1-0.3 inches.

In one method of constructing the device, each individual cell growth chamber **114** is separately made. A unitarily molded piece incorporating a top surface **118**, side walls **120**, spacers **122**, and circular bosses **128** in the form of descending truncated cones are made. The circular bosses **128** descend from the top surface a distance roughly equivalent with height of the side walls **120**. In one embodiment, the circular bosses **122** have a diameter at the top that is larger than the diameter at the bottom. A membrane film making up the bottom surface **116** is heat sealed to the periphery of the cell chamber along the bottom edge of the side walls and is also fused to the circular bottom of each boss **128**.

In one embodiment, the walls defining the circular bosses **128** extend below the level of the height of the side walls **120**. As part of this extension, a stepped locking feature **130** embedded within the wall of the boss exists that is capable of mating with the respective top portion **132** of a circular boss from another unitarily molded piece. In this embodiment, the film making up the bottom growth surface **116** is heat welded around the walls of each boss **128** creating a liquid tight seal and leaving holes through the cell growth chamber defined by the walls of the respective bosses **128**. Consecutive cell

growth chambers may then be snap fitted together by engaging the circular bosses from the respective chambers as shown in FIG. **3**.

Once the desired number of cell growth chambers **114** are assembled and locked together through the circular bosses **128**, the respective layers are heat welded together along grooves **134** in the outer surface of the flask. A hot metal column is pressed against the outside of the assembled cell growth chambers orthogonal to the plane defined by the cell growth layers and in various groove locations **134** around the periphery of the flask. This has the effect of "heat staking" or melting the polymer in the areas falling into contact with the heated column and thereby welding the assembly together. Although any number of outer welds may be employed, in one embodiment, there are two welds along each respective side wall of the flask.

Under certain conditions of use, the press fit locking features of the bosses in combination with the welds along the outer walls of the flask are not enough to hold the flask unit together and leaking may occur as pressure builds within the flask. In order to provide an additional means of securing the stacked cell growth chambers together, a unitary connecting column **138** may be employed. The connecting column is driven through the cavity created by the consecutively stacked interlocking bosses **128**. It extends from the lower surface **104** of the flask **100**, through the holes left in each cell growth chamber, to the upper surface **102** of the flask. The connecting column is sealed on both ends to ensure the respective cell growth chambers do not separate, even under pressurized conditions. In one embodiment, the connecting column **138** is made from the same polymer material as the top surface of the flask and has a flattened head portion **140** and an elongated pin portion **142**. The flattened head portion engages the bottom of the flask while the elongated pin portion extends through the cell growth chambers and extends beyond the upper surface **102** of the flask **100**. Once in position, the end of the connecting column **138** may be heat staked to the upper surface of the flask. As such, the melted tip **144** is mushroomed over and integrally joined with the material comprising the upper surface of the flask. FIG. **3** shows one connecting column (on the right) extending through the flask and above the upper surface created in the boss. It also shows a second connecting column (on the left) having its tip **144** melted along the walls of the boss. The melted tips in combination with the flattened head create a bonded seal holding the stacked cell growth chambers together.

Alternatively, the connecting column may be threaded on the end opposite the headed end such that it can be bolted at the upper surface. In another embodiment, opposing headed pins, one entering the cavity from the lower surface of the flask and the other entering from the upper surface of the flask may be snap fitted together within the cavity creating the unitary connecting column.

The advantage of utilizing the connecting columns has been demonstrated by pressure testing of polystyrene vessels made both with the connecting column and without the connecting columns. In those vessels made without the connecting columns, pressurization testing indicated that failure of the device occurs anywhere between 0.9 and 1.1 psi. For those vessels employing the connecting columns, pressure testing was employed to levels as high 3.0 psi and no failure occurred.

The apparatus **100** of the present invention may be made by any number of acceptable manufacturing methods well known to those of skill in the art. In a preferred method, the apparatus **100** is assembled from a collection of separately injection molded parts. Though any polymer suitable for molding and commonly utilized in the manufacture of laboratory ware may be used, polystyrene is used in one embodiment. Although not required, for optical clarity, it is advantageous to maintain a thickness of no greater than 2 mm.

The top surfaces **118** of each cell growth chamber **114** as well as the manifold **108** and neck portion **110** are injection molded. The bottom surfaces **116** are made from membrane that has been extruded, for example.

Gas permeable, liquid impermeable bottom surfaces **116** may be comprised of one or more membranes known in the art. Suitable materials for use as membranes include for example: polystyrene, polyethylene, polycarbonate, polyolefin, ethylene vinyl acetate, polypropylene, polysulfone, polytetrafluoroethylene (PTFE) or compatible fluoropolymer, a silicone rubber or copolymer, poly(styrene-butadiene-styrene) or combinations of these materials. The membrane may be of any thickness, preferably between about 25 and 250 microns, but ideally between approximately 25 and 125 microns. The membrane allows for the free exchange of gases between the interior of the flask and the external environment and may take any size or shape, so long as the membrane is supportive of cellular growth.

The connecting column **138** may be made from any suitable polymer resin material including polystyrene or any of those deemed suitable by one of skill in the art. Alternatively, the connecting column may be created from an inorganic material such as a metal, glass, ceramic, or glass ceramic.

The gas permeable membrane bottom surfaces **116** are properly affixed to the side walls of the respective top surfaces **118** by any number of methods including but not limited to adhesive or solvent bonding, heat sealing or welding, compression, ultrasonic welding, laser welding and/or any other method commonly used for generating seals between parts. Laser welding around the circumference of the membrane is preferred to establish a hermetic seal around the membrane region such that the membrane is flush with and fused to the face of the side walls such it becomes an integral portion of the interior surface of the apparatus. The parts are held together and are adhesive bonded along the seam, ultrasonically welded, or laser welded. Preferably, laser welding equipment is utilized in a partially or fully automated assembly system.

In order to enhance cell-attachment and growth, the surfaces internal to the apparatus may be treated to enable cell growth. Treatment may be accomplished by any number of methods known in the art which include plasma discharge, corona discharge, gas plasma discharge, ion bombardment, ionizing radiation, and high intensity UV light.

When a cap **112** is provided, it may be a screw cap, snap-fit cap, cap with septum, cap with air holes, or any cap known in the art. In one embodiment, a cap **112** is utilized in which a septum is integral with the cap **112**. This will allow a cannula, tip or needle to access the contents of the apparatus without the need for unscrewing. The septum is leak proof, puncturable and capable of resealing once the needle, tip or cannula is removed from the apparatus, even after multiple punctures.

In use, the apparatus of the current invention is employed according to accepted cell growth methods. Cells are introduced to the apparatus **100** though the aperture via the neck (or through a septum in the aperture). Along with the cells, media is introduced such that the cells are immersed in the media. The apparatus is arranged such that the cell containing media covers the cell growth bottom surfaces **116**. The apparatus **100** is capable of being completely filled with media since the gas permeable membrane bottom surfaces **116** in combination with the tracheal spaces **124** provide uniform gas distribution to the cell growth bottom surfaces **116**. This

will further ensure the flow and exchange of gases between flask interior and the external environment. The apparatus is then placed within an incubator and may be stacked together with similar vessels such that a number of cell cultures are simultaneously grown. The apparatus is situated such that the lower surface **104** assumes a horizontal position.

Cell growth is monitored from time to time by microscopic inspection through the generally transparent interior and exterior surfaces of the apparatus **100**. Easier accessibility and greater visibility of cellular growth can be achieved when optical lenses having varying magnifications are employed around the outside of the apparatus. During the cell growth process, it may become necessary to extract the exhausted media and insert fresh media. As previously described, media replacement may be achieved through insertion of a canula, for example, through the septum. Alternatively, the media may be replaced by removing the cap **112**, in embodiments that offer this option. Once the cells are ready for harvesting, a chemical additive such as trypsin is added to the apparatus through the septum. The trypsin has the effect of releasing the cells from the surfaces of the apparatus. The cells can then be harvested from the flask. The disclosed embodiments of the present invention may be modified to take the shape of any multilayered device, container, apparatus, vessel, or flask currently used in industry. Specifically, multiple layered cylindrical or alternative vessels may utilize gas permeable substrates (internal to the vessel) in combination with tracheal chambers or spaces to provide an improved culturing environment for the growth of cells. Additionally it may be conceived that any multiple layered stacked laboratory device may employ the connecting columns disclosed herein.

Various embodiments of the invention have been described herein. The descriptions are intended to be illustrative, not limiting. Thus, it will be apparent to those skilled in the art that modifications may be made to the invention as described without departing from the scope of the claims set out below.

The invention claimed is:

1. A cell culture apparatus having a plurality of stacked cell culture chambers, comprising:

at least a first cell culture chamber formed by a first top surface, an opposing first bottom surface spaced apart from the first top surface, and a first sidewall around the first chamber and extending between the first top surface and the first bottom surface; and;

at least a second cell culture chamber formed by a second top surface, an opposing second bottom surface spaced apart from the second top surface, and a second sidewall around the second chamber and extending between the second top surface and the second bottom surface;

wherein each of the plurality of cell culture chambers comprise at least one internal boss defined by walls connecting the top and bottom surfaces of each of the plurality of cell culture chambers, wherein the internal boss walls have an inner and outer surface, and each internal boss has a diameter at the top surface of each of the plurality of cell culture chambers that is larger than a diameter at the bottom surface of each of the plurality of cell culture chambers, and

wherein the internal boss of a first stacked cell culture chamber fittingly engages with the internal boss of a second stacked cell culture chamber with the inner walls of the internal bosses defining a cavity through the plurality of cell culture chambers; and,

at least one unitary connecting column running continuously through the cavity from a bottom of the cell culture apparatus to a top of the cell culture apparatus.

2. The apparatus according to claim **1**, space between the first bottom surface and second top surface.

3. The apparatus according to claim **2**, further comprising a rigid planar lower surface spaced away from the second bottom surface but contacting the second sidewall along a periphery and wherein the cell culture chambers are combined into an integral flask unit.

4. The apparatus according to claim **3**, wherein the integral flask unit has a substantially rectangular footprint and a substantially uniform height.

5. The apparatus according to claim **4**, wherein the tracheal space is an air chamber in communication with the external environment.

6. The apparatus of claim **2**, further comprising additional cell culture chambers stacked in succession above the first and second cell culture chambers, each cell culture chamber having a tracheal space formed between the bottom surface of a cell culture chamber and the top surface of an adjacent cell culture chamber.

7. The apparatus according to claim **2**, wherein a neck is located within the substantially rectangular footprint and does not exceed the height of the integral flask unit.

8. The apparatus of claim **1**, wherein the bosses take the form of truncated cones.

9. The apparatus of claim **1**, wherein each internal boss further comprises a top portion and a bottom portion and a step feature on the outer wall of the internal boss proximate to the bottom portion for fittingly engaging the inner wall of the top portion of the internal boss from a cell culture chamber immediately below.

10. The apparatus of claim **1**, wherein the unitary connecting column further comprises a flattened head portion and an elongated pin portion, the flattened head portion engaging the bottom of the cell culture apparatus.

11. The apparatus of claim **1**, wherein the unitary connecting column is made from a polymer, a glass, a glass ceramic or a metallic material.

12. The apparatus of claim **1**, wherein at least one of the bottom surfaces is permeable and liquid impermeable.

13. The apparatus according to claim **1**, wherein the internal bosses support a film that forms the top surface or the bottom surface of the cell culture chamber, and the unitary connecting column is separated from the film by the internal boss walls.

14. The apparatus according to claim **13**, wherein the unitary connecting column does not support the film.

15. A multilayered flask comprising:

at least a first cell culture chamber formed by a first top surface, an opposing first bottom surface spaced apart from the first top surface, and a first sidewall around the first chamber and extending between the first top surface and the first bottom surface; and;

at least a second cell culture chamber formed by a second top surface, an opposing second bottom surface spaced apart from the second top surface, and a second sidewall around the second chamber and extending between the second top surface and the second bottom surface;

wherein the first cell culture chamber and the second cell culture chamber are stacked in successive orientation to form a multilayered flask having at least two cell culture chambers;

a plurality of internal bosses defined by walls connecting the bottom surface of the first cell culture chamber with the top surface of the adjacent second cell culture chamber, the internal boss walls having an inner and outer surface, a top surface and a bottom surface, each internal

boss having a diameter at each top surface that is larger than a diameter at each bottom surface;

wherein a first internal boss fittingly engages with a second internal boss to formed stacked internal bosses, the inner walls of the stacked internal bosses defining a cavity through the stacked cell culture chambers; and

at least one unitary connecting column running continuously through the cavity formed by the stacked internal bosses, from the first top surface to the second bottom surface.

16. The apparatus of claim **15**, wherein the connecting column further comprises a flattened head portion and an elongated pin portion, the flattened head portion engaging the second bottom surface.

17. The apparatus of claim **15**, wherein the connecting pin is made from a polymer, a glass, a glass ceramic or a metallic material.

* * * * *

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(12) **United States Patent**
Martin et al.

(10) **Patent No.: US 8,273,572 B2**
(45) **Date of Patent: Sep. 25, 2012**

(54) **METHODS OF USING MULTILAYERED CELL CULTURE APPARATUS**

(75) Inventors: **Gregory R. Martin**, Acton, ME (US); **Allison J. Tanner**, Portsmouth, NH (US)

(73) Assignee: **Corning Incorporated**, Corning, NY (US)

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Related U.S. Application Data

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(51) **Int. Cl.**
C12M 1/20 (2006.01)

(52) **U.S. Cl.** **435/383**; 435/401; 435/294.1; 435/304.3

(58) **Field of Classification Search** ..... None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,225,671	A	9/1980	Puchinger et al.	435/71
4,296,205	A	10/1981	Verma	435/240
4,661,455	A	4/1987	Hubbard	435/240
4,734,373	A	3/1988	Bartal	435/296
4,748,124	A	5/1988	Vogler	435/240.241
4,770,854	A	9/1988	Lyman	422/102
4,839,292	A	6/1989	Cremonese	435/313
4,938,196	A	7/1990	Hoshi et al.	123/489
4,945,203	A	7/1990	Soodak et al.	219/121.64
5,026,650	A	6/1991	Schwarz et al.	435/286
5,047,347	A	9/1991	Cline	435/296
5,079,168	A	1/1992	Amiot	437/284
5,139,946	A	8/1992	Howell et al.	435/240.2
5,149,649	A	9/1992	Miyamori et al.	435/240.242
5,153,131	A	10/1992	Wolf et al.	435/240.24
5,310,676	A	5/1994	Johansson et al.	435/285
5,330,908	A	7/1994	Spaulding	435/240.24
5,416,022	A	5/1995	Amiot	435/284
5,437,998	A	8/1995	Schwarz et al.	435/286
5,476,573	A	12/1995	Hirose et al.	202/197
5,523,236	A	6/1996	Nuzzo	435/304.1
5,527,705	A	6/1996	Mussi et al.	435/297.1
5,565,353	A	10/1996	Klebe et al.	435/240.25
5,589,112	A	12/1996	Spaulding	264/413
5,597,731	A	1/1997	Young et al.	435/284.1
5,602,028	A	2/1997	Minchinton	435/401
5,627,070	A	5/1997	Gruenberg	435/786.5
5,658,797	A	8/1997	Bader	435/284.1
5,686,301	A	11/1997	Falkenberg et al.	435/297.1
5,686,304	A	11/1997	Codner	435/325
5,693,537	A	12/1997	Wilson et al.	435/401
5,702,941	A	12/1997	Schwarz	435/243
5,714,384	A	2/1998	Wilson et al.	435/401
5,763,261	A	6/1998	Gruenberg	435/286.5
5,763,275	A	6/1998	Nagels et al.	435/373
5,763,279	A	6/1998	Schwarz et al.	435/383
5,783,440	A	7/1998	Stevens	435/304.3
5,786,215	A	7/1998	Brown et al.	435/401
5,801,054	A	9/1998	Kiel	435/297.5
5,912,177	A	6/1999	Turner et al.	435/455
5,924,583	A	7/1999	Stevens et al.	215/40
6,107,085	A	8/2000	Coughlin et al.	435/299.1
6,114,165	A	9/2000	Cai et al.	435/304.3
6,190,913	B1	2/2001	Singh	435/394
6,297,046	B1	10/2001	Smith et al.	435/297.5
6,323,022	B1	11/2001	Chang et al.	435/286.5
6,410,309	B1	6/2002	Barbera-Guillem et al.	435/297.5
6,455,310	B1	9/2002	Barbera-Guillem	435/383
6,465,243	B2	10/2002	Okada et al.	435/301.1
6,468,792	B1	10/2002	Bader	435/325
6,518,035	B1	2/2003	Ashby et al.	435/18
6,548,263	B1	4/2003	Kapur et al.	435/7.2
6,555,365	B2	4/2003	Barbera-Guillem et al.	435/303.1
6,569,675	B2	5/2003	Wall et al.	435/304.2
6,576,458	B1	6/2003	Sarem et al.	435/286.5
6,588,586	B2	7/2003	Abasolo et al.	206/204
6,593,136	B1	7/2003	Geiss	435/325

(Continued)

FOREIGN PATENT DOCUMENTS

EP	0307048	3/1989

(Continued)

OTHER PUBLICATIONS

E. Metzen, M. Wolff, J. Fandrey, and W. Jelkmann, Pericellular PO2 and O2 consumption in monolayer cell cultures, Respiration Physiology 100 (1995) 101-106.

(Continued)

Primary Examiner — Jim Ketter
(74) *Attorney, Agent, or Firm* — Susan S. Wilks

(57) **ABSTRACT**

A multilayered cell culture apparatus for the culturing of cells is disclosed. The cell culture apparatus is defined as an integral structure having a plurality of cell culture chambers in combination with tracheal space(s). The body of the apparatus has imparted therein gas permeable membranes in combination with tracheal spaces that will allow the free flow of gases between the cell culture chambers and the external environment. The flask body also includes an aperture that will allow access to the cell growth chambers by means of a needle or cannula. The size of the apparatus, and location of an optional neck and cap section, allows for its manipulation by standard automated assay equipment, further making the apparatus ideal for high throughput applications.

2 Claims, 10 Drawing Sheets

U.S. PATENT DOCUMENTS

6,653,124	B1	11/2003	Freeman	435/297.1
6,673,595	B2	1/2004	Barbera-Guillem	435/286.2
6,759,245	B1	7/2004	Toner et al.	435/401
6,794,184	B1	9/2004	Mohr et al.	435/294.1
6,811,752	B2	11/2004	Barbera-Guillem	422/100
6,818,438	B2	11/2004	Muser	435/304.3
6,821,772	B2	11/2004	Barbera-Guillem et al.	435/297.5
6,841,384	B2	1/2005	Robbins, Jr.	435/325
6,855,542	B2	2/2005	DiMilla et al.	435/289.1
6,908,767	B2	6/2005	Bader	435/395
7,022,518	B1	4/2006	Feye	435/297.1
7,078,228	B2	7/2006	Lacey et al.	435/288.1
7,160,687	B1	1/2007	Kapur et al.	435/7.2
7,192,769	B2	3/2007	Pykett et al.	435/373
7,195,758	B2	3/2007	Schultze et al.	424/93.71
2002/0039785	A1	4/2002	Schroeder et al.	435/304.3
2002/0110905	A1	8/2002	Barbera-Guillem et al.	435/294.1
2003/0008388	A1	1/2003	Barbera-Guillem et al.	435/297.5
2003/0008389	A1	1/2003	Carll	435/302.1
2003/0040104	A1	2/2003	Barbera-Guillem	435/286.2
2003/0143727	A1	7/2003	Chang	435/289.1
2004/0029266	A1	2/2004	Barbera-Guillem	435/297.5
2004/0043481	A1	3/2004	Wilson	435/297.1
2004/0072347	A1	4/2004	Schuler et al.	435/372
2004/0132175	A1	7/2004	Vetillard et al.	435/297.1
2005/0009179	A1	1/2005	Gemmiti et al.	435/420
2005/0032208	A1	2/2005	Oh et al.	435/366
2005/0077225	A1	4/2005	Usher et al.	210/321.6
2005/0101009	A1	5/2005	Wilson et al.	435/295.3
2005/0106717	A1	5/2005	Wilson et al.	435/297.5
2005/0169962	A1	8/2005	Bhatia et al.	424/423
2005/0260745	A1	11/2005	Domansky et al.	435/294.1
2006/0003436	A1	1/2006	DiMilla et al.	435/284.1
2006/0019361	A1	1/2006	Ng et al.	435/177
2006/0031955	A1	2/2006	West et al.	800/24
2006/0112438	A1	5/2006	West et al.	800/17
2006/0121606	A1	6/2006	Ito et al.	435/325
2006/0136182	A1	6/2006	Vacanti et al.	703/11
2006/0141617	A1	6/2006	Desai et al.	435/325
2006/0252150	A1	11/2006	Cheng	435/372
2007/0026516	A1	2/2007	Martin et al.	435/297.5
2008/0176318	A1	7/2008	Wilson et al.	435/297.1
2008/0227176	A1	9/2008	Wilson	435/243

FOREIGN PATENT DOCUMENTS

EP	155237 B1	5/1989
EP	0 725 134	8/1996
EP	0 890 636	10/2001
GB	1 539 263	1/1979
GB	2268187	1/1994
JP	2004-147555 A	5/2004
WO	WO 90/05179	5/1990
WO	WO 91/15570	10/1991
WO	WO 00/56870	9/2000
WO	WO 00/78932	12/2000
WO	WO 01/92462	12/2001
WO	WO/02/066595	8/2002
WO	WO 03/085080	10/2003
WO	WO 2004/106484	12/2004
WO	WO 2005/035728	4/2005

OTHER PUBLICATIONS

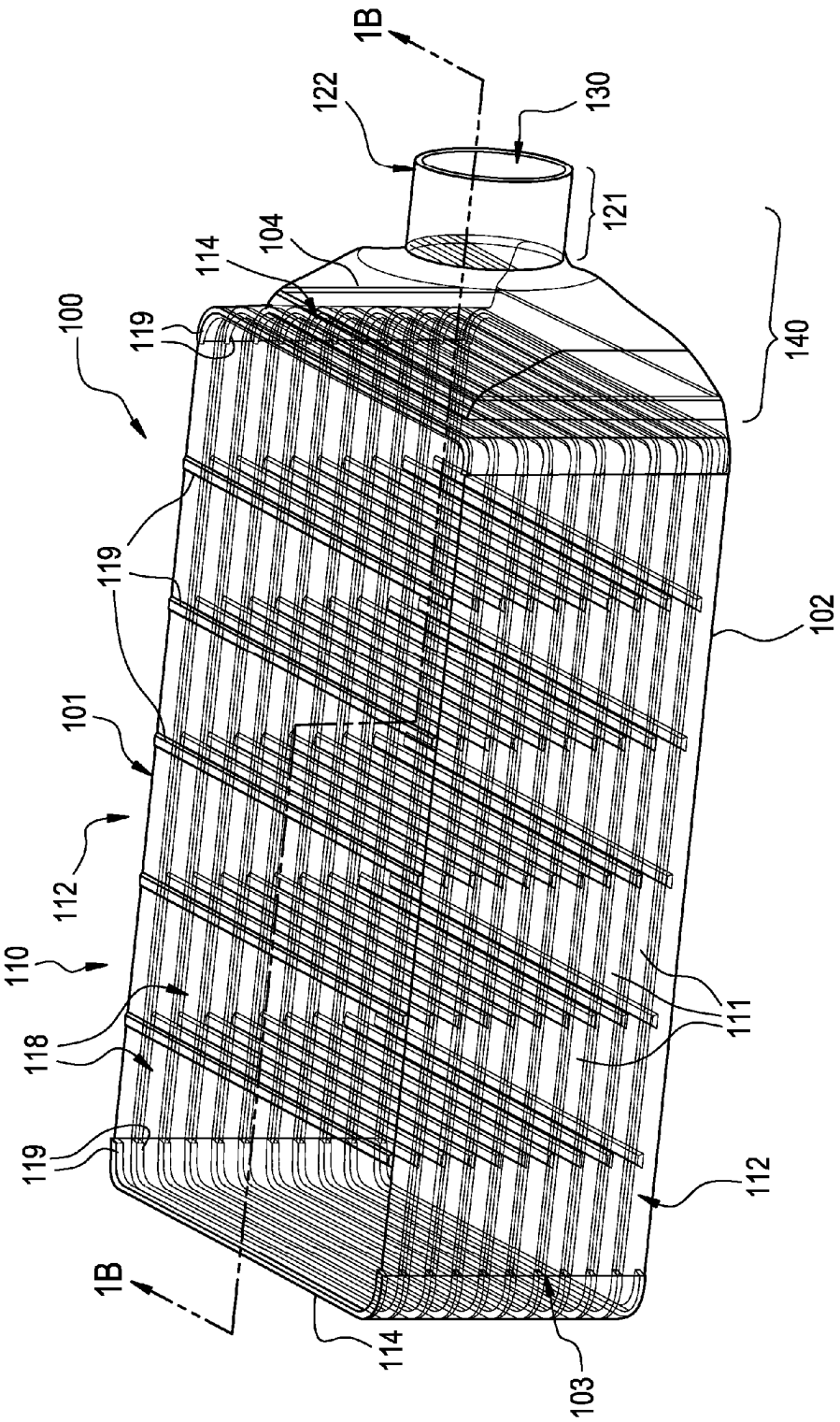
Kamel Mamchaoui and Georges Saumon, A method for measuring the oxygen consumption of intact cell monolayers, American Journal of Physiology Lung Cellular and Molecular Physiology (2000) 278: L858-L863.

E. Barbera-Guillem, "Overcoming cell culture barriers to meet the demands of cell biology and biotechnology", Reprinted from American Biotechnology Laboratory, May 2001.

"Cell Culture Equipment (Hardware & Devices)", Lab Times, Products, Jan. 2006, pp. 52-58.

US 6,465,252, 10/2002, Toner et al. (withdrawn).

FIG. 1A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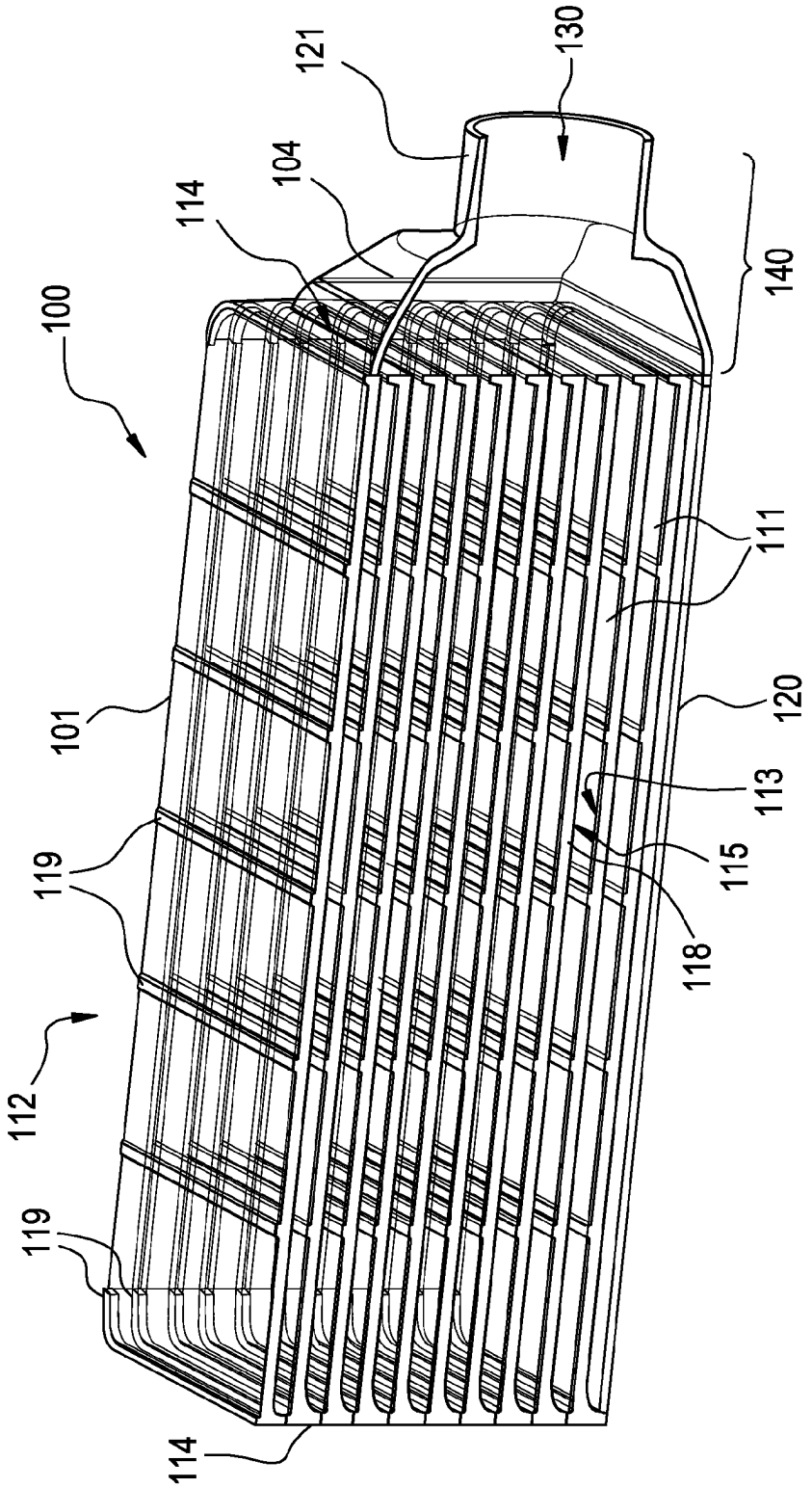


FIG. 1B

FIG. 1C

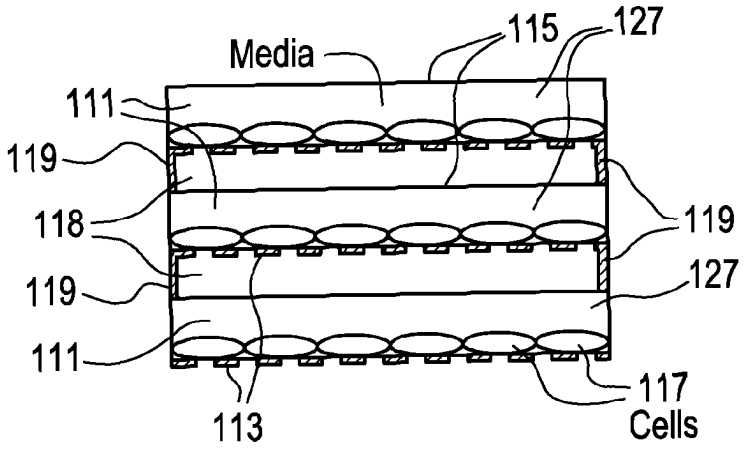


FIG. 2

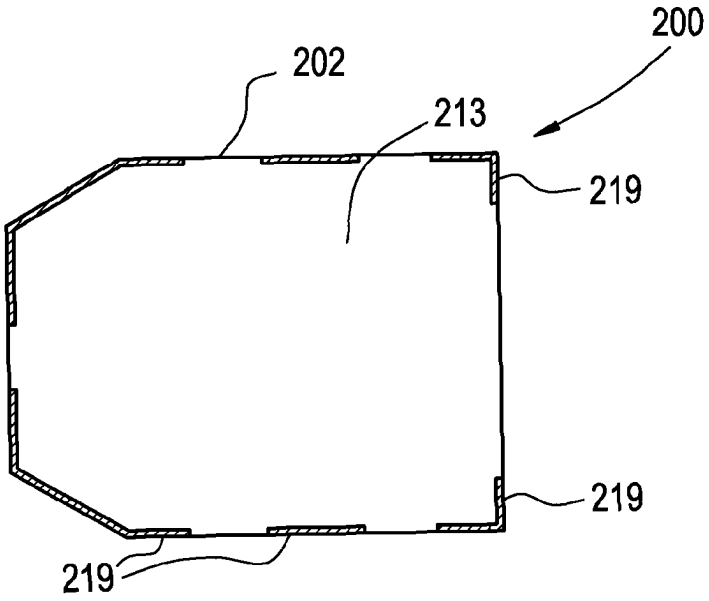
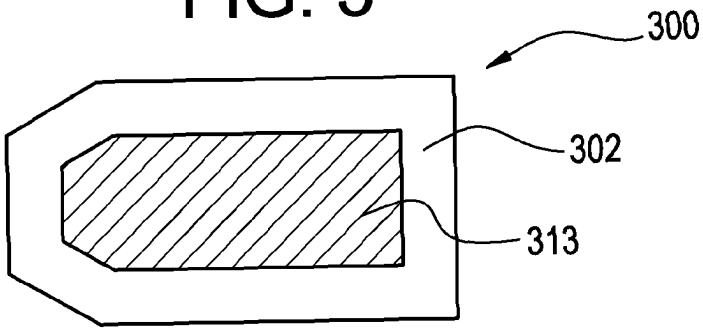


FIG. 3



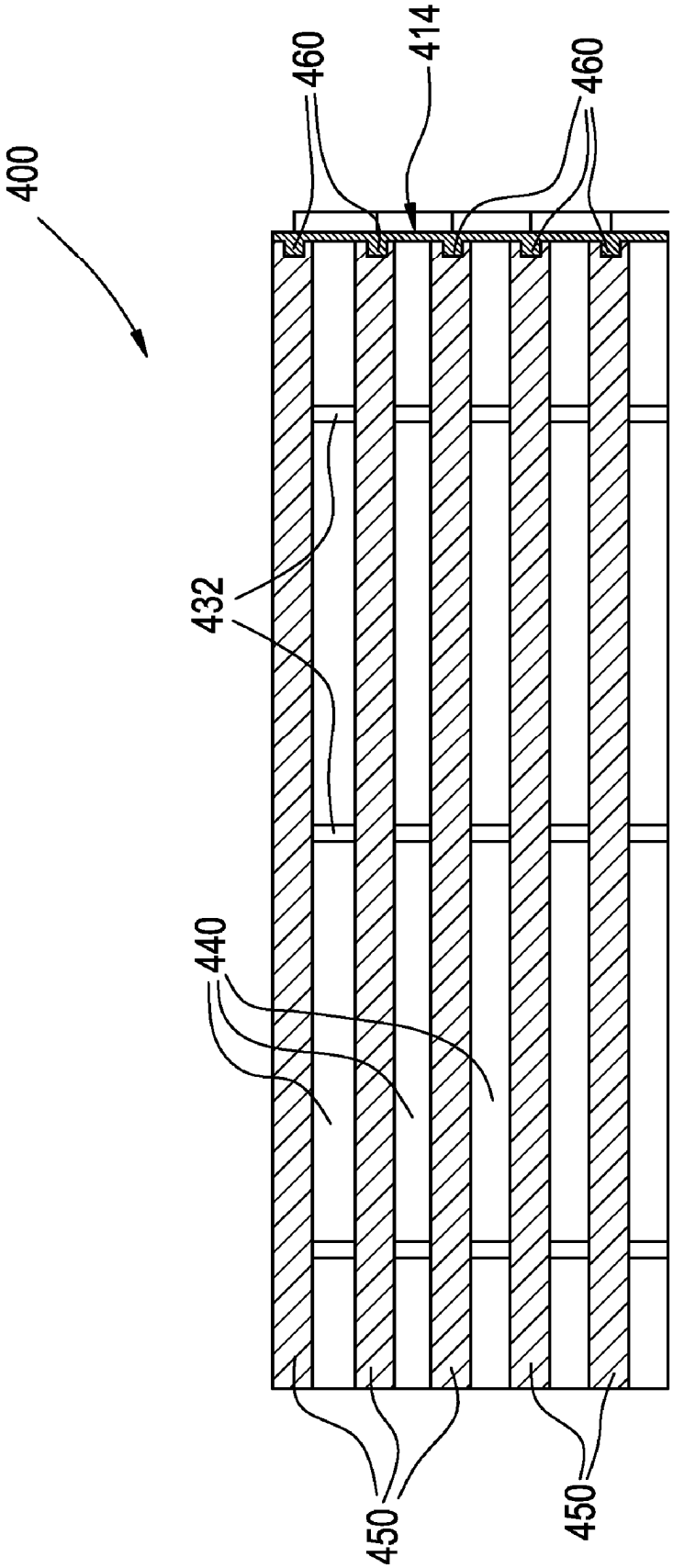


FIG. 4

FIG. 5

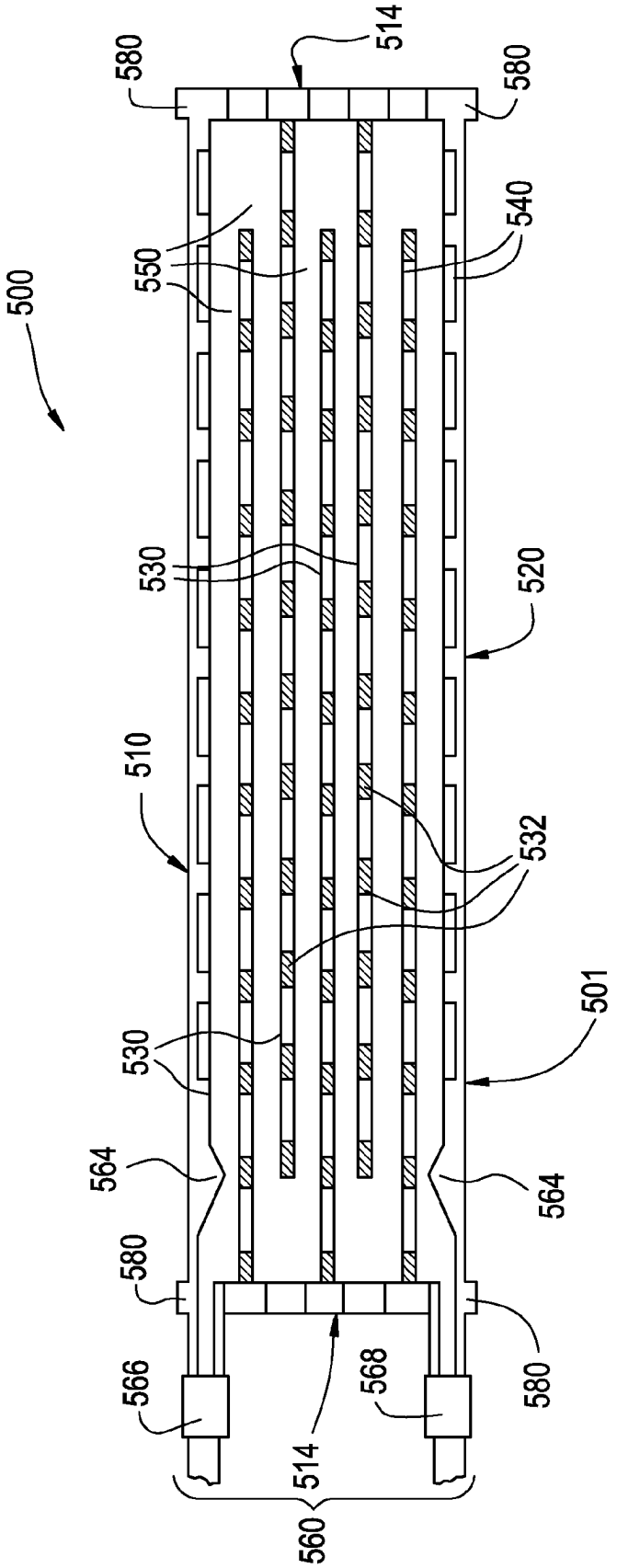

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FIG. 5A

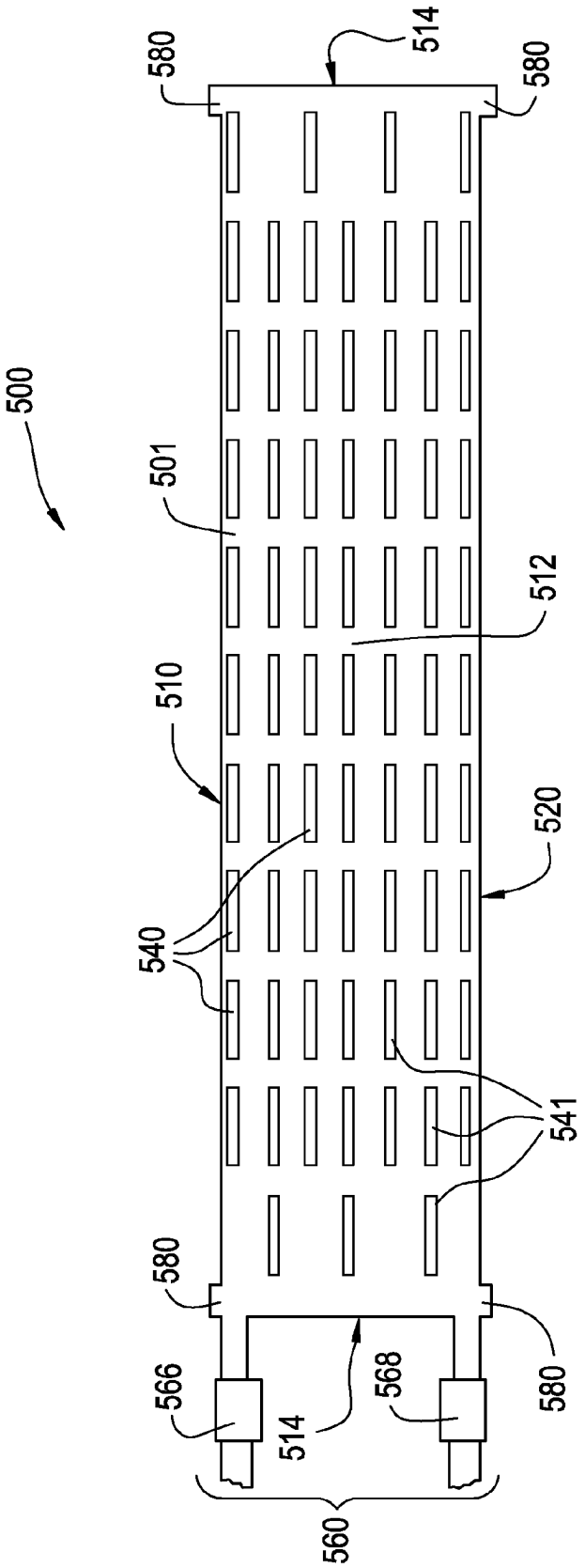


FIG. 6

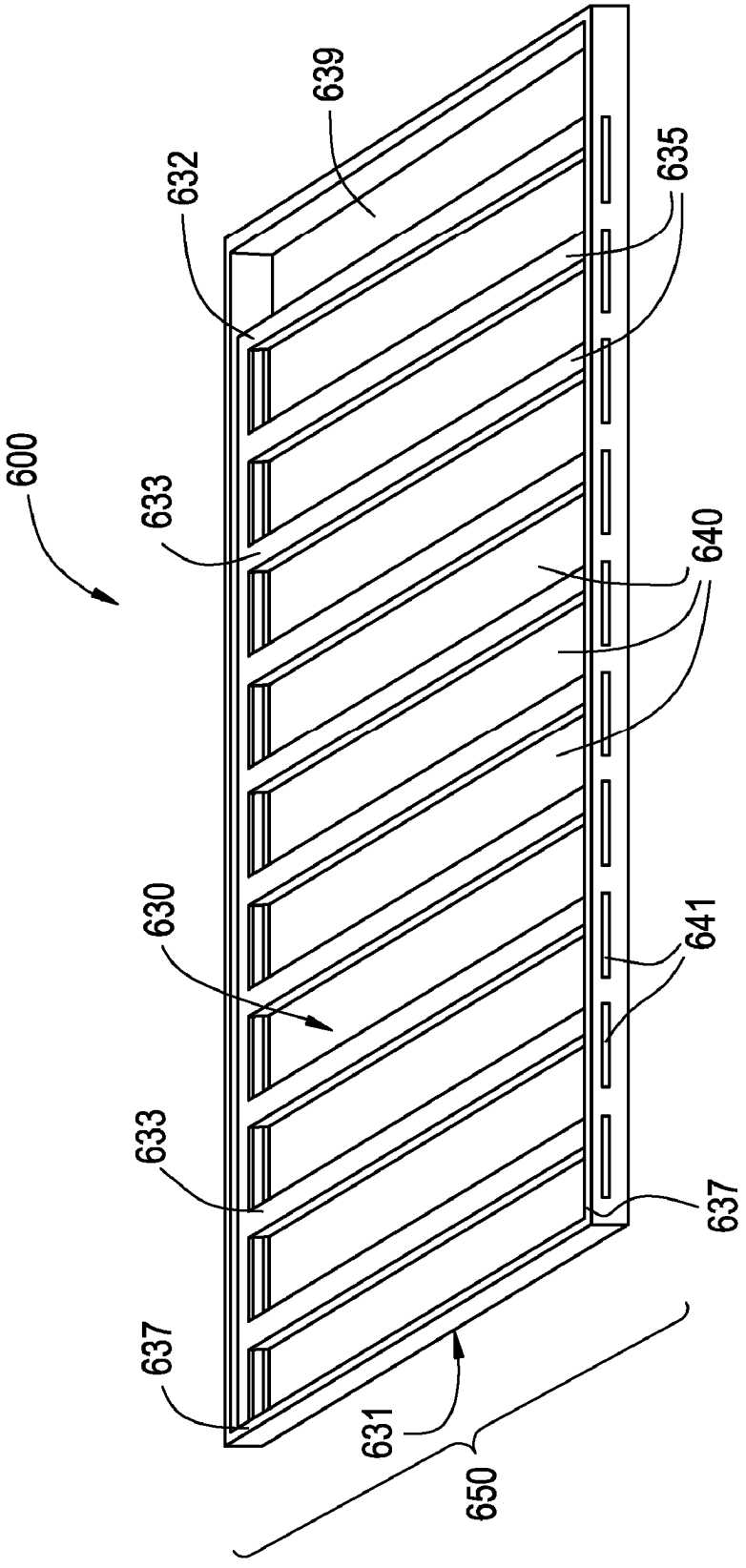


FIG. 7

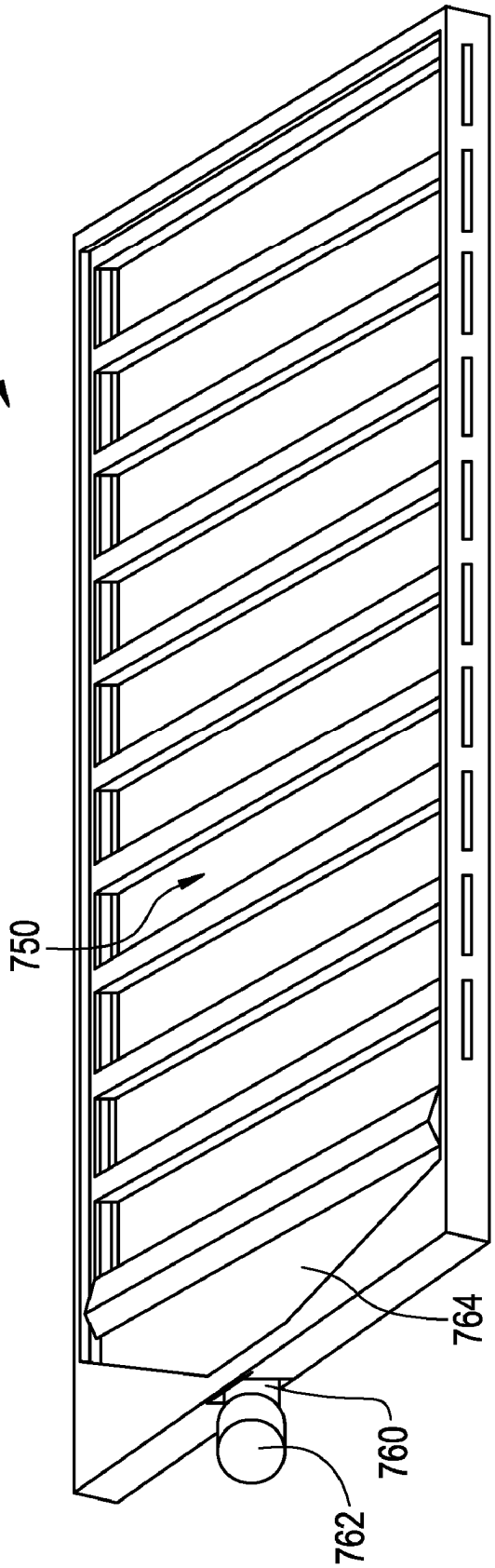


FIG. 8

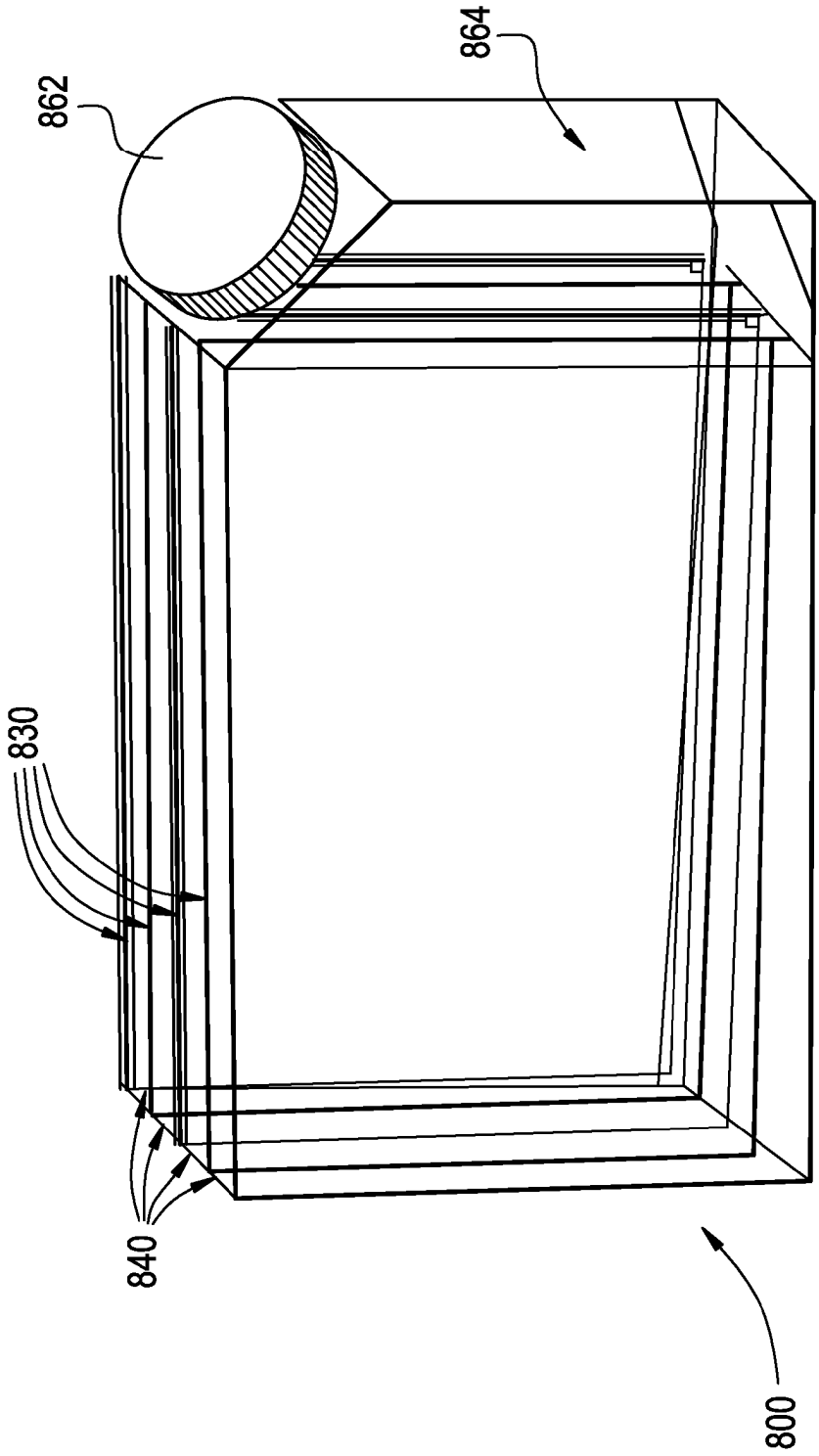
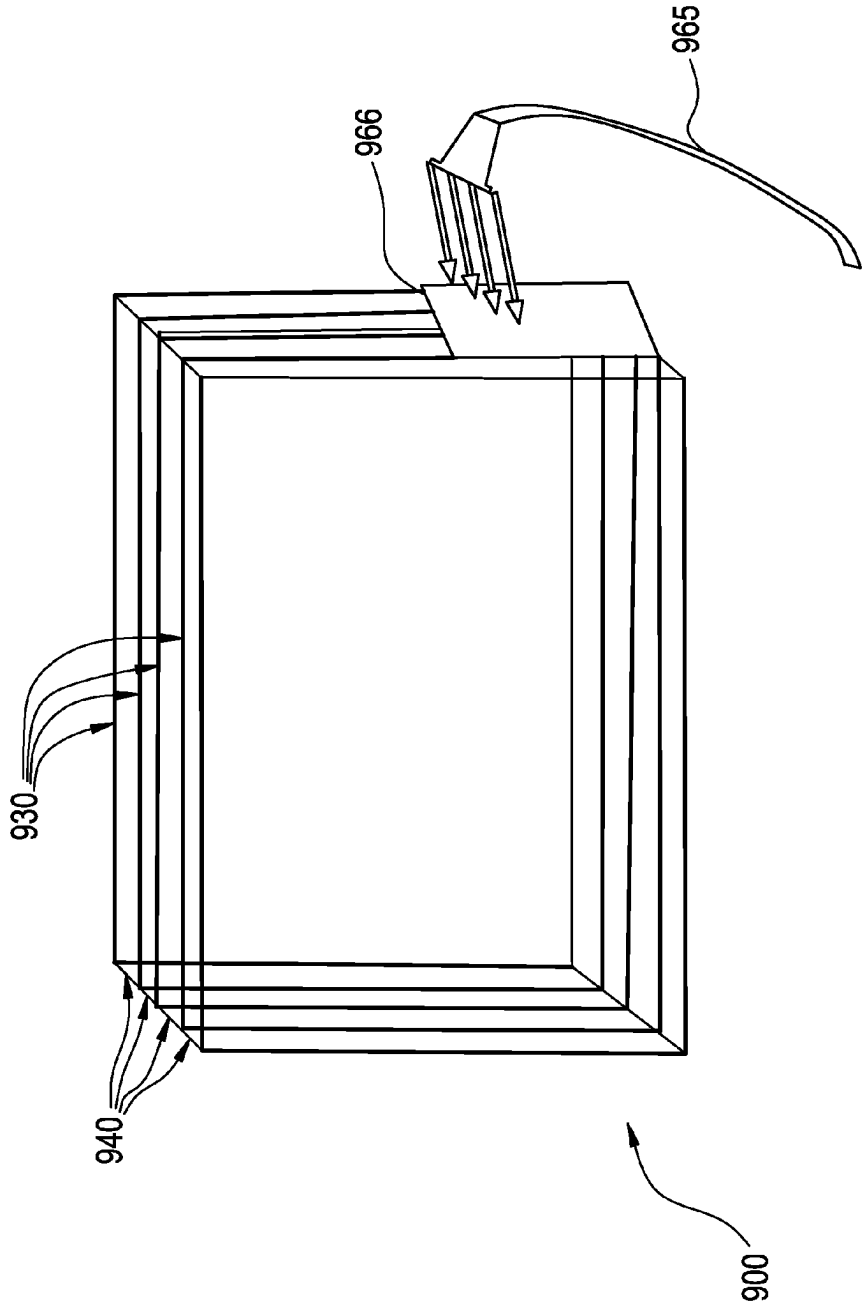


FIG. 9



METHODS OF USING MULTILAYERED CELL CULTURE APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a divisional of and claims the benefit of priority to U.S. application Ser. No. 11/433,859, filed on May 11, 2006, now U.S. Pat. No. 7,745,209 which claims the benefit of U.S. Application Ser. No. 60/702,896 filed on Jul. 26, 2005 and entitled "Multilayered Cell Culture Apparatus" which are incorporated by reference herein in.

FIELD OF THE INVENTION

The present invention relates generally to the cellular biological field and, in particular, to a cell cultivating flask.

BACKGROUND OF THE INVENTION

In vitro culturing of cells provides material necessary for research in pharmacology, physiology, and toxicology. The environmental conditions created for cultured cells should resemble as closely as possible the conditions experienced by the cells in vivo. One example of a suitable environment for culturing cells is a common laboratory flask such as demonstrated in U.S. Pat. No. 4,770,854 to Lyman. The cells attach to and grow on the bottom wall of the flask, immersed in a suitable sustaining media. The flask is kept in an incubator to maintain it at the proper temperature and atmosphere.

Although most cells will tolerate a hydrogen ion concentration (pH) range of 6.8 to 7.8, the optimal pH for growth of mammalian cells is 7.2 to 7.4. For the optimal pH to be maintained during cell cultivation, the cell culture medium must contain a buffering system.

Frequently, pH is maintained by using a bicarbonate buffering system in the medium, in conjunction with an incubator atmosphere of approximately 5 to 7 percent carbon dioxide by volume. The carbon dioxide reacts with the water to form carbonic acid which in turn interacts with bicarbonate ions in the medium to form a buffering system which maintains the pH near physiological levels. Entry of carbon dioxide from the incubator into the cell culture flask is generally achieved by using a loosely fitting or vented cap or cover so that the small opening remains for the exchange of gas between flask and incubator. Further, flasks have been sold that are made from impact resistant polystyrene plastic which is permeable to water vapor, oxygen and carbon dioxide. However, relying only on the gas exchange through the polystyrene is generally ineffective since the vessel wall thickness greatly decreases the permeability rate. Further still, flasks have been made having a cell growth surface that is itself an extremely thin (approximately 0.004 inches thick) flexible, gas permeable membrane. While this type of construction allows for gas exchange, the flexibility and thinness of the growth surface makes the growth of a uniform surface difficult and contributes to problems associated with the durability of the flask.

Gas exchange, particularly the utilization of oxygen by the cells, is a factor that limits the area for cell growth within a cell culture flask. Since flasks for cell culture typically grow attachment dependent cells in a monolayer roughly equal in size to the footprint of the flask, media volume is therefore restricted to an area within the flask permissive to the diffusion of oxygen. Oxygen and carbon dioxide are of particular importance to the culturing of cells. The supply of oxygen for cellular respiration and metabolic function in conventional cell culture containers occupies the head space of the container, e.g., the void space in the container that is above the surface of the cell culture medium. Thus, the volume of the container and the surfaces within conventional cell culture containers are inefficiently used. This results in limiting the rate of gas exchange and/or restricting the equilibration of gases. There is a need for a cell culture flask that can provide an increased surface area for cell growth while still permitting sufficient gas exchange for the multitude of attachment dependent cells.

Desirably, many flasks are stacked together in the incubator and a number of cultures are simultaneously grown. Small variations in the growth medium, temperature, and cell variability have a pronounced effect on the progress of the cultures. Consequently, repeated microscopic visual inspections are needed to monitor the growth of the cells. As such, cell culture flasks are typically constructed of optically clear material that will allow such visual inspection.

With the advent of cell-based high throughput applications, fully automated cell culture systems have been the subject of serious development work (see e.g. A Review of Cell Culture Automation, M. E. Kempner, R. A. Felder, JALA Volume 7, No. 2, April/May 2002, pp. 56-62.) These automated systems employ traditional cell culture vessels (i.e. common flasks, roller bottles, and cell culture dishes) and invariably require articulated aims to uncap flasks and manipulate them much like the manual operator.

There is a need for a cell culture apparatus having a rigid structure that is capable of providing an increased surface area for cell growth while also providing necessary gas exchange. Even further, it is desirable to produce a greater cell yield within commonly known flask volumes while permitting gas exchange at a surface of cell attachment.

Additionally, the desired cell culture apparatus will be suitable for use in the performance of high throughput assay applications that commonly employ robotic manipulation.

SUMMARY OF THE INVENTION

According to an illustrative embodiment of the present invention, a cell growth apparatus for efficient culturing of cells is disclosed. The illustrative apparatus includes a unitary body including a bottom tray defining a cell growth area and a top plate, connected by side walls and end walls. At least one aperture located along any periphery of the apparatus permits access to the internal volume. At least one gas permeable substrate/membrane is affixed to a support internal to the body of the apparatus. A tracheal space/chamber permits gases from an external atmosphere to be exchanged across the gas permeable, liquid impermeable membrane, into and out of the cell culture chamber(s). Further, the tracheal space is an air chamber confined by an outer vessel body. Communication between a tracheal chamber and a cell growth chamber provides a uniformity of conditions for cellular growth. Furthermore, a uniform gaseous distribution can be beneficial in providing consistency in the culturing environment.

One embodiment of a cell growth apparatus of the present invention includes a plurality of cell growth chambers, each having a gas permeable, liquid impermeable surface and an opposing surface. At least one tracheal chamber is in communication with at least one gas permeable, liquid impermeable surface of a cell growth chamber so that cells can exchange gases (e.g. oxygen, carbon dioxide, etc.) with an external environment. The cell growth apparatus of the present invention has at least one tracheal chamber incorporated with a plurality of cell growth chambers combined into one integral unit. The integral unit thus has multiple growth surfaces in any assembled arrangement. A preferred embodi-

ment of a cell growth apparatus of the present invention alternates each cell growth chamber with a tracheal chamber in a vertical successive orientation whereby each cell growth chamber includes a substantially planar horizontal surface supporting the growth of attachment-dependent cells. The cell growth surface, however, may be planar and/or nonplanar to accommodate the surface area for growth. A modified or enhanced surface area in combination with one or more tracheal spaces enables a diversified area for growing cells. Subsequently, another embodiment of the present invention may include an arrangement of surfaces intermediary to cell growth surfaces and tracheal spaces. As such, cell growth chambers may be adjoined and configured so that they still have communication with a tracheal chamber.

When a plurality of cell culture chambers are arranged with tracheal chambers formed there-between, the tracheal chambers permit gaseous exchange between the gas permeable, liquid impermeable surface of a cell culture chamber and the external atmosphere. In a preferred embodiment of the present invention, each cell culture chamber alternates with a tracheal chamber allowing the cells greater access to external gaseous exchange.

One embodiment of the apparatus of the present invention utilizes a gas permeable, liquid impermeable membrane as the opposing surface of a cell culture chamber. In such an embodiment, a plurality of gas permeable substrates (internal to the body of the apparatus) can be incorporated to increase surface area for cellular growth. Preferably then, the apparatus is capable of being rotated to facilitate the growth of attachment-dependent cells on an alternate surface. Each gas permeable substrate may have a tracheal space above and/or below it. One such embodiment is capable of incorporating one or more tracheal spaces between each stacked gas permeable substrate/layer. Additionally, the gas permeable membrane(s) may be treated or coated to promote cell growth.

Another embodiment of the present invention includes one or more supports to for a shelf internal to the apparatus. As such, each shelf would have at least one gas permeable substrate affixed. An alternative embodiment may incorporate lateral ribs traversing the flask body such that an internal gas permeable membrane would be further capable of supporting cellular growth. When such supports or lateral ribs are utilized, a plurality of gas permeable membranes can be arranged or housed within the support itself or affixed to one or more surfaces of the supports. It would therefore be important then, when stacking the layers or gas permeable substrates, to include a tracheal space between each layer of cell growth. Preferably, the tracheal space(s) provide uniform gaseous distribution within the cell culture chamber of the internal apparatus. Completely filling the apparatus with media would allow for optimal cellular nutrient exchange. Consequently, the uniformity of conditions for cellular growth may include a determined media volume per unit surface area. In another aspect, an integral unit of the cell culture apparatus comprises a plurality of modules, each having a cell growth chamber and a tracheal chamber. The plurality of modular gas permeable substrates are utilized to permit a plurality of cell chambers and tracheal chambers to be arranged to form one unitary apparatus of the present invention. The plurality of layers of gas permeable substrates are further capable of being interconnected or adjoined to provide a multiplicity of areas for cellular growth. The plurality of modules may be interconnected in series or staggered to permit continuous flow. For easy assembly and disassembly, individual units having snap-like features could be securely and easily adjoined.

In another embodiment of the present invention, the apparatus comprises a manifold to access the cell growth chambers of an integral unit. The manifold may further be capable of directing the flow of air, liquid, media and/or cellular material within the cell culture chamber.

While many embodiments of the present invention are suitable for static cultures, another embodiment of the present invention staggers the gas permeable substrates within the flask to permit continuous flow through the cell culture chamber. The staggered layers allow media to continuously flow or perfuse through the apparatus.

One embodiment of the present invention provides compliance with conventionally sized and shaped containers currently used such that the apparatus, device or flask of the present invention may be utilized with various equipment and instrumentation. Thus, the apparatus of the present invention may have a substantially rectangular footprint and a substantially uniform height. The rectangular footprint would have dimensions that are substantially identical to an industry standard footprint dimension for microplates. One embodiment of the configuration of the apparatus then may include a neck and/or cap located within the substantially rectangular footprint and that does not exceed the height of the integral unit.

Another embodiment of the apparatus of the present invention may comprise stand-offs either rising from an exterior surface of the top plate or descending from an exterior surface of the bottom tray.

For the addition and removal of media, the cell growth apparatus has at least one access port to access multiple growth chambers. Each cell growth chamber, however, may have individual access ports. Supplementary, the apparatus is capable of being equipped with a septum seal accessible opening or aperture either integrated within the body of the apparatus itself, or as a part of a cap. When a cap is utilized, one embodiment of the apparatus of the present invention, having a height as measured by the distance between an outermost plane of the bottom tray and an outermost plane of the top plate, has a cap, cover, and/or septum covering the aperture. The cap may have a diameter that does not exceed the height of the apparatus/flask so as to prevent interference when the flasks are stacked. Additionally, the cap may be integrally included in a top surface, side, and/or corner region of the apparatus. The apparatus of the present invention may have an aperture which defines an entry portal and another which may define an exit portal. When gas permeable substrates are stacked, the entry and exit portals may be positioned in a parallel or staggered assembly so as to permit flow or perfusion through cell culture chambers within the body of the apparatus.

Convenience then dictates the utilization of one or more optical components, such as microscopic lenses, in communication with individual cell growth chambers. These lenses would allow observation of one or more layers of cell growth. Also, and advantageously so, the apparatus is shaped and configured to enable robotic access to the interior of the apparatus without requiring cumbersome robotic aim manipulation.

The present invention also includes a method of culturing cells in the apparatus of the present invention. The method initially involves providing a apparatus for the growth of cells as previously described. Gas permeable substrates are first assembled into the desired configuration of the apparatus followed by introduction of cells and/or media into the cell culture chamber of the apparatus. Thereafter, the flask can then be incubated to meet the desirable conditions for the

growth of cells. Rotation of the apparatus further permits the culturing of cells on an alternate surface of the gas permeable substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is best understood from the following detailed description when read with the accompanying drawing figures. It is emphasized that the various features are not necessarily drawn to scale. In fact, the dimensions may be arbitrarily increased or decreased for clarity of discussion.

FIG. **1**A is a perspective external view of an illustrative embodiment of the apparatus of the present invention.

FIG. **1**B is a cross-sectional perspective side view of an illustrative embodiment of the present invention.

FIG. **1**C is a partial internal side view of intermediary supports and gas permeable growth surfaces of FIG. **1**A.

FIG. **2** is a top view of supports utilized in another embodiment of the present invention.

FIG. **3** is an external top view of a frame supporting a gas permeable membrane in another embodiment of the present invention.

FIG. **4** is a cross-sectional side view of another illustrative embodiment of the present invention.

FIG. **5** is an internal side view of the interconnected chambers of one embodiment of the present invention.

FIG. **5**A is a side view of the external frame/body of the embodiment of FIG. **5**.

FIG. **6** is an individual unit of one embodiment of the present invention.

FIG. **7** is another individual unit or tray of an embodiment of the present invention.

FIG. **8** is an alternative embodiment of the present invention.

FIG. **9** is another embodiment of the present invention.

DETAILED DESCRIPTION

In the following detailed description, for purposes of explanation and not limitation, exemplary embodiments disclosing specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one having ordinary skill in the art that the present invention may be practiced in other embodiments that depart from the specific details disclosed herein. In other instances, detailed descriptions of well-known devices and methods may be omitted so as not to obscure the description of the present invention.

An external view of a apparatus in accordance with one embodiment of the present invention is shown in FIG. **1**. The apparatus **100** of this embodiment takes the form of a flask **100**; the flask **100** comprises an outer vessel body **101** (see FIG. **1**A) defined by a top plate **110**, a bottom tray **120**, sidewalls **112**, and end walls **114**. Disposed within the flask **100** are individual cell growth chambers **111** as can be seen more clearly in a cross-sectional illustration in FIGS. **1**B and **1**C. The individual cell growth chambers **111** are each defined by a generally transparent bottom surface **113** and a generally transparent top surface **115**. The surfaces **113** and **115** are attached to the flask body **101** along the sidewalls **112** and end walls **114**. Preferably, at least one bottom surface **113** within each chamber **111** is gas permeable, liquid impermeable material and capable for the growth of cells **117**. Each top surface **115** is preferably a rigid, generally gas impermeable material (preferably transparent) that will provide support to the cell growth chamber **111**. In this embodiment, supports **119** allow a gas permeable membrane **113** to be securely adhered thereto in a leak-proof sealing to the flask body **101**. Tracheal spaces **118** are created between each cell growth chamber **111**. The opposing top surface **115** of the chamber **111** defines an upper wall to the cell growth chamber **111** as well as a bottom portion of a tracheal chamber **118**. The tracheal chamber **118** is therefore inclusive of a gas permeable, liquid impermeable surface **113** of a first cell growth chamber and an opposing surface **115** to a second growth chamber **111**. Supports **119** further provide structural arrangements to integrally incorporate the surfaces **113** and **115** in knitting growth chambers **111** in alternation with tracheal air spaces **118** within the unitary flask **101**. Each cell growth chamber **111** therefore alternates with a tracheal chamber **118** in vertical successive orientation. Accessibility to the cellular growth chambers **111** is achieved via an aperture **120** within the flask body **101**. The aperture **120** having a necked opening **121** is connected to the cell growth chambers **111** via a manifold **104**. The manifold **104** is a portal for manipulation of flask contents. In this embodiment, the necked opening **121** is covered by a cap **122** allowing the flask to be completely filled with media **127** without leakage.

In one embodiment of the present invention, the chambers **111** permit cellular growth on gas permeable membranes **113** such that multiple cell growth chambers **111** are integral with the body **101** of the apparatus **100** and are capable of being completely filled with nutrient media for the growth of cells. The series of tracheal air spaces **118** through the apparatus **100** provide gaseous communication between the cells **117** of the internal volume of the apparatus and the external environment. The tracheal spaces **118** allow oxygenation of media located within cell growth chambers **111** through the gas permeable surfaces **113**. Further, the tracheal chambers **118** may take the form of any air gap or space, and do not allow entrance of liquid. As a result, a rigid cell culture apparatus **100** having multiple growth chambers **111**, alternating with tracheal spaces **118**, is cooperatively constructed to afford the benefit of equivalent gaseous distribution to a large volume of cells **117**. Supplementary, the aperture **120** of the flask is resealable by way of a septum and/or cap **122** to prevent contents of the flask from spilling.

The apparatus **100** of the present invention may be made by any number of acceptable manufacturing methods well known to those of skill in the art. In a preferred method, the apparatus **100** is assembled from a collection of separately injection molded parts. Though any polymer suitable for molding and commonly utilized in the manufacture of laboratory ware may be used, polystyrene is preferred. Although not required, for optical clarity, it is advantageous to maintain a thickness of no greater than 2 mm.

The bottom tray **120** and top plate **110** are preferably injection molded. Various sizes and shapes of the supports **119** may be incorporated to facilitate positioning of the membranous layers **113** for cell culture **117** within the internal flask body **101**. A top view of another embodiment of the present invention (FIG. **2**) has supports **219** as elevated stand-offs **219** along a frame or edge **202** of the flask **100**. The supports **219** are rigid structures to support a sheet of gas permeable membrane **213** adhered to the frame **202**, as well as provide a structural framework to allow multiple layers (rigid or membranous **213**) to be formed within the flask **200**. Alternatively, FIG. **3** illustrates an inner surface **313**, whereby only a portion of each cell growth chamber **300** is gas permeable. For instance, a rigid frame **302** may support a permeable membrane **313**.

Gas permeable, liquid impermeable substrates **113** may be comprised of one or more membranes known in the art. Membranes typically comprise suitable materials that may include

for example: polystyrene, polyethylene, polycarbonate, polyolefin, ethylene vinyl acetate, polypropylene, polysulfone, polytetrafluoroethylene (PTFE) or compatible fluoropolymer, a silicone rubber or copolymer, poly(styrene-butadiene-styrene) or combinations of these materials. As manufacturing and compatibility for the growth of cells permits, various polymeric materials may be utilized. For its known competency, then, polystyrene may be a preferred material for the membrane (of about 0.003 inches in thickness, though various thicknesses are also permissive of cell growth). As such, the membrane may be of any thickness, preferably between about 25 and 250 microns, but ideally between approximately 25 and 125 microns. The membrane **113** allows for the free exchange of gases between the interior of the flask and the external environment and may take any size or shape, so long as the membrane is supportive of cellular growth. A preferred embodiment would include a membrane **113** that is additionally durable for manufacture, handling, and manipulation of the apparatus.

The gas permeable membrane **113** is properly affixed to the supports **119** by any number of methods including but not limited to adhesive or solvent bonding, heat sealing or welding, compression, ultrasonic welding, laser welding and/or any other method commonly used for generating seals between parts. Laser welding around the circumference of the membrane **130** is preferred to establish a hermetic seal around the membrane region such that the membrane is flush with and fused to the face of the supports **132** such it becomes an integral portion of the interior surface of the apparatus. Once the gas permeable membrane **130** is adhered, then the top plate **110** and bottom tray **120** may be joined. The parts are held together and are adhesive bonded along the seam, ultrasonically welded, or laser welded. Preferably, laser welding equipment is utilized in a partially or fully automated assembly system. The top plate and tray are properly aligned while a laser weld is made along the outer periphery of the joint.

Advantageously and in order to enhance cell attachment and growth, the surfaces internal to the apparatus **100** are treated to enable cell growth. Treatment may be accomplished by any number of methods known in the art which include plasma discharge, corona discharge, gas plasma discharge, ion bombardment, ionizing radiation, and high intensity UV light.

Finally, when a cap **122** is provided, it may be a screw cap, snap-fit cap, cap with septum, cap with air holes, or any cap known in the art. Preferably, a cap **122** is utilized in which a septum is integral with the cap **122**. This will allow a cannula, tip or needle to access the contents of the apparatus **100** without the need for unscrewing. The septum is leak proof, puncturable and capable of resealing once the needle, tip or cannula is removed from the apparatus, even after multiple punctures. In one embodiment, the cap **122** is positioned to access the contents of the apparatus **100** via an end wall **114**. As well, the cap **122** may be positioned on a top surface **110**. Additionally, the cap arrangement can also be located such that the cap **122** does not protrude from the rectangular footprint as determined by the periphery of the apparatus **100**. Other accessibility options may include a neck and cap arrangement within a corner region of the apparatus **100**, such that the cap **122** would not protrude from the periphery of the apparatus body **101**.

In use, the apparatus **100** of the current invention is employed according to accepted cell growth methods. Cells are introduced to the apparatus **100** though the aperture via the neck (or through a septum in the aperture). Along with the cells **117**, media **127** is introduced such that the cells are immersed in the media. The apparatus is arranged such that the cell containing media covers the cell growth surfaces **113**. Advantageously, the apparatus **100** is capable of being completely filled with media since the gas permeable membranes **113** in combination with the tracheal spaces **118** provide uniform gas distribution to the cell growth surfaces **113**. This will further ensure the flow and exchange of gases between flask interior and the external environment. The apparatus is then placed within an incubator and may be stacked together with similar vessels such that a number of cell cultures are simultaneously grown. The apparatus is situated such that the bottom tray **120** assumes a horizontal position (or vertical position depending on the cell culture application). Another advantage of the apparatus **101** of the present invention is its enhanced capacity to grow cells on an opposing surface **115** when the apparatus is rotated 180°. Thus, when the apparatus is rotated, cells can be cultured on an alternate surface **115**. As such, it would be beneficial to have the surface **115** composed of a gas permeable material. Where only gas permeable membranes are layered intermediary to the apparatus, cell growth is therefore enabled on both of its gas permeable surfaces **113/115**.

Cell growth is monitored from time to time by microscopic inspection through the generally transparent interior and exterior surfaces of the apparatus **100**. Easier accessibility and greater visibility of cellular growth can be visualized when optical lenses having varying magnifications are employed in the external body **101**. Additionally, optical lenses may be integrated within other internal surfaces of the apparatus **100**.

Additionally, during the cell growth process, it may become necessary to extract the exhausted media and insert fresh media. As previously described, media replacement may be achieved through insertion of a canula, for example, through the septum. Alternatively, the media may be replaced by removing the cap **122**, in embodiments that offer this option. Once the cells are ready for harvesting, a chemical additive such as trypsin is added to the apparatus through the septum. The trypsin has the effect of releasing the cells from the surfaces of the apparatus. The cells can then be harvested from the flask.

A cap and neck arrangement is not necessary, however, for an apparatus **400** of the present invention (FIG. **4**). As illustrated in this embodiment, supports **432** separate a series of tracheal spaces **440** between each growth layer **450**. The tracheal air spaces provide uniform gas distribution within the flask **400** to each cell culture layer **450**. In this embodiment, the media in the individual cell growth chambers does not mix as these chambers **450** can be considered separate, and possibly, modular units **450** for easy assembly of the apparatus **400**. The chambers **450**, however, may be interconnected via hollow supports **432**. In one embodiment, access to the interior of the apparatus **400** may be accomplished directly, through plugged ports or apertures **460** that are on an end wall **414** to allow accessibility to each cell culture/media layer **450**. Another easy means of access may employ septa as coverings for the apertures **460**.

Septa are capable of being integrally affixed to the body of the apparatus **400** by any of the aforementioned methods for affixing a membrane to the wall of the apparatus. The septa may take any form well known to those of skill in the art including a slit arrangement useful for blunt needles and as generally described in WO 02/066595, the contents of which are incorporated herein by reference. Possible materials that may be employed in making the septa include natural and synthetic elastomeric materials including, but not limited to silicone rubber, fluoro-carbon rubber, butyl rubber, polychloroprene rubber, a silicone elastomer composite material, ther-

moplastic elastomer, medical grades of silicone rubber, polyisoprene, a synthetic isoprene, silicone, santoprene and fluoropolymer laminate and combinations thereof. In a preferred embodiment, the elastomeric material is substantially nontoxic to cultured cells. Moreover, a universal septum may cover each aperture **460** while still allowing access to each individual layer of cell growth **450**. This embodiment of the flask **400** may be preferred when stacking of the apparatus **400** is required, or when significant robotic manipulation is encountered since it eliminates the need for cap displacement.

FIGS. **5** and **5**A illustrate another embodiment of the present invention. As illustrated in partial internal and external cross-sectional views, respectively, a multilayered culture vessel **501** of the present invention is a perfusion system **500**. Multiple gas permeable substrates **530** are adhered to supports/frames **532** and stacked in a parallel configuration permitting an airway or tracheal space **540** to separate each cellular growth layer **550**. As in previous embodiments, the gas permeable substrates/membranes **530** in combination with the tracheal chambers **540** define the cell culture system **500**. The tracheal spaces **540**, alternating with layers of transparent gas permeable membrane(s) **530** and supports **532**, provide air/gas exchange with media and cell cultures **550** on an alternate or opposing surface of the gas permeable substrate **530**. As such, liquid media inside the apparatus **501** is capable of being contained within a layer **550**. In addition, the tracheal air chambers **540** under each cell growth surface **550** have gaseous communication between the cells/media layers **550** and external environment via the series of openings **541** formed between the supports **532** in the external apparatus body **501**. The necked opening **560** comprises one aperture which defines an entry portal **562** and one aperture which defines an exit portal **564**. The entry portal **566** and exit portal **568** in conjunction with the necked opening **560** allows access to the internal volume/layers **550** of the apparatus **500**. Furthermore, in this embodiment of the apparatus/vessel **501**, a raised rim **580** serving as a standoff **580** is located on the surfaces of both the top plate **510** and bottom plate **520**. The standoff rim **580** is intended to contact the bottom tray **520** of an identical vessel that is stacked on top the apparatus **501**. Stacking makes efficient use of incubator space. Another attribute of having a standoff rim **580** is the allowance of an air gap between stacked flasks; the air gap is important for allowing gas exchange through any vent that may be incorporated into an upper or underside surface of the apparatus **501**, and further prevents damage to the gas permeable membrane **530**. Other alternatives for standoffs **580** include raised corners, posts, ledges, or any other feature that will allow spacing between successively stacked flasks. Preferably, the bottom plate **520** is molded with a rim **580** around the periphery that can engage with a standoff rim **580** from an immediately adjacent apparatus to ensure lateral stability of the stacked vessels.

For exemplary purposes and not limitation, cell seedlings, media exchange, and/or cell harvesting can be accessed via the entry portal(s) **566** and exit portal(s) **568**. In combination with the portals **566**/**568**, linear fluid flow restrictors **564** can act as manifolds to evenly direct flow during cell harvesting. Additionally, for exemplary purposes only and not limitation, an embodiment of the present invention incorporates a staggered configuration of gas permeable substrates **530** in conjunction with the supports **532** so as to allow continuous flow or perfusion through the vessel **501**. Various arrangements of the layers **550** and stacked substrates **530**, however, would permit utilization of the vessel **501** for static cell culture or cell culture in a perfusion system as discussed, including parallel, symmetrical, or asymmetrical arrangements.

For easier accessibility and manufacturing of the multilayered apparatus **501**, the arrangement of cell growth layers **550** and stacked substrates **530** into individual modular units may be preferred. As such, a modular unit of one embodiment of the present invention is illustrated in FIG. **6**. An individual modular unit **600** comprises a support network **632** in combination with gas permeable membranes/substrates **630**. A plurality of modular units **600** are capable of being interconnected and/or interlocked or adhered together to provide a multiplicity of growth surfaces **630**/**631** that can be easily assembled or disassembled into a unitary multilayered vessel for cellular culture. Vertical stacking of the modular units **600** would be analogous to interconnecting building blocks. Any number of cell growth layers **600** could be assembled or disassembled to provide a wide range of accessibility options to each modular cell growth unit **600**. One embodiment of the present invention utilizes supports **632** forming a shelf/frame **633** along a periphery of the individual unit **600** in addition to lateral ribs **635** spanning or bisecting the distance internal to the frame **633**. The transparent gas permeable substrate(s) **630** are adhered to supports **632** such that air gaps or tracheal spaces **640** are formed between each cell layer of gas permeable substrate **630** to allow gas distribution throughout the unitary apparatus when multiple trays are assembled into one vessel body. The tracheal spaces **640** have gaseous exchange with the external atmosphere via the tracheal openings/ports **641** in the external frame **633**. Further, the tracheal spaces **640** provide air/gas exchange with media and cell cultures on a [primary] surface **630** and an alternate or secondary surface **631**, both surfaces **630**/**631** capable of cell growth. As seen in this embodiment, peripheral ridges or elevations **637** of the support system **632** are utilized to facilitate stacking of the modular units **600**. The gas permeable membrane **630**, however, may be adhered to any of the surfaces of the support system **632** or peripheral edge **637** so as to provide a leak-proof gas permeable substrate **630** in combination with the modular unit **600** and further permitting multiple areas for cell growth on the gas permeable surfaces **630**/**631**. Additionally, an open end **633** of the frame **632** is a feature to permit fluid flow when multiple modular units **600** are stacked and adhered together into a unitary body so as to be utilized in perfusion devices. Furthermore, one embodiment of the apparatus of the present invention encompasses one gas permeable substrate **630** providing a primary growth surface **630**, as well as an [optional] gas permeable substrate **631** providing a secondary growth surface **631** adhered to an underside of the frame network **632**.

As seen in FIG. **7**, another embodiment of the present invention utilizes a modular unit **700** inclusive of a cap **762** covering an aperture **760**. A manifold **764** permits access to the internal cell culture layer **750**. A unitary cell culture chamber is capable of being constructed when individual units **600** and/or **700** are stacked. Further, when combined, the internal cell culture layers **650** and/or **750** would be accessible via the aperture **760** to the unitary cell culture chamber.

In utilizing the vessels of the current invention, various methods in the industry may be employed in accordance with accepted cell growth culturing. As discussed in a previous embodiment, cells are introduced to the flask though the neck or through the septum. Along with the cells, media is introduced such that the cells are immersed in the media. The apparatus is arranged such that the cell-containing media covers the cell growth surfaces. Advantageously, the apparatus is capable of being completely filled with media since the gas permeable membranes in combination with the tracheal spaces provide uniform gas distribution to the cell growth surfaces. This will furthermore ensure the flow and exchange

of gases between flask interior and the external environment. The apparatus is then placed within an incubator and may be stacked together with similar flasks such that a number of cell cultures are simultaneously grown. The flask is situated such that the bottom tray assumes a horizontal position (or vertical position depending on the cell culture application). The flask can then be rotated to permit the culturing of cells on an alternate surface. Where only gas permeable membranes are layered intermediary to the apparatus, cell growth is enabled on upper and under sides of the membrane (opposing gas permeable surfaces).

Cell growth can be monitored from time to time by microscopic inspection through the generally transparent surfaces. If more detailed visual inspection of the cell growth layers is required, optical lenses can be integrated into the body or frame of the apparatus. As such, varying magnifications of the optical lenses would permit viewing within individual layers without disassembly of the apparatus. Optical lenses may be incorporated into any surface or modular unit, as well, preferably when the units are capable of being disassembled for observational analysis.

During the cell growth process, it may become necessary to extract the exhausted media and insert fresh media. As previously described, media replacement may be achieved through insertion of a canula, for example, through the septum. Alternatively, the media may be replaced by removing the cap, in embodiments that offer this option. Once the cells are ready for harvesting, a chemical additive such as trypsin is added to the flask through the septum. The trypsin has the effect of releasing the cells from the vessel surfaces. The cells are then harvested from the apparatus.

As discussed, the embodiments of the present invention are for exemplary purposes only and not limitation. Supplementary, tracheal spaces are capable of being formed above and/or below the support network when the trays are stacked upon one another where peripheral ridges of individual modular units permit gaps of air to flow through gas permeable substrates to cell growth areas when the units are interconnected. The tracheal spaces formed within the individual units are further capable of including a diversified network of supports, intersecting and/or alternating gas permeable membrane with supports and air/tracheal spaces.

The gas permeable substrates utilized in the embodiments of the present invention are capable of cell growth and gas exchange with the external environment, achieving uniform gaseous distribution throughout the cell culture vessel. Furthermore, the apparatus of the present invention may utilize horizontal or vertical designs having surfaces arranged for uniform gaseous distribution to cell growth areas. As seen in one embodiment of the present invention in FIG. **8**, vertical growth surfaces or gas permeable substrates **830** are separated by tracheal spaces **840**. The tracheal spaces **840** allow for the exchange of oxygen, carbon dioxide, and other various gases between the respiratory/gas permeable surfaces **830** that the cells grow on and the incubator or external atmosphere where the apparatus **800** is stored while the cells are given time to grow. The apparatus **800** of the present invention may include a cap **862** and/or a manifold **864**, as well, which is unitary with the vessel body **800**.

Another embodiment of the present invention (FIG. **9**) is an apparatus **900** that includes an external manifold **965** allowing access to individual cell growth layers **930** via a septum as discussed previously. The units **930** are modular and joined together to handle as one. Furthermore, tracheal spaces **940** allow uniform gaseous distribution to cell growth areas **930** throughout the flask **900**. The uniformity of conditions for cellular growth may include a determined media volume per unit surface area. Though the determined ratio of volume per unit surface area has previously been known within a confined range of about 0.5-1.0 ml/cm^2, the ratio is no longer limiting due to the direct access of the cells to gaseous exchange via the gas permeable membrane upon which the cells grow. While efficient use of media is still preferable, any volume of media may be utilized in an apparatus of this invention, the apparatus of which may be any size and/or take any shape. Further, the enhanced capabilities of the present invention may incorporate tracheal spaces in combination with cell growth chambers into standardized or conventionally-sized containers. One embodiment of the apparatus of the present invention includes an increased surface area for cellular growth preferably with a ratio of media volume per unit surface area in the range of about 0.25-0.50 ml/cm^2; however, the dimensions and confines for cellular growth are unlimited. One such embodiment would include a height of about 2.8 mm. As stated previously, however, the height is unrestricted so long as it permits area for the growth of cells. Furthermore, by completely filling the cell growth chambers with media, the cells have access to optimal nutrient exchange.

The embodiments of the present invention may be modified to take the shape of any device, container, apparatus, vessel, or flask currently used in industry. Specifically, cylindrical or alternative vessels may utilize gas permeable substrates (internal to the vessel) in combination with tracheal chambers or spaces to provide an improved culturing environment for the growth of cells. A spiral or alternative approach inclusive of a tracheal chamber would therefore be possible. Further, although tracheal chambers may take many forms and be of any size, the passageway-like chambers are: a) confined air spaces, b) in communication with a gas permeable membrane that is permissive to cell growth, and c) communicative with the external environment via open direct access and/or additional gas permeable membranes.

As presented, the multiple embodiments of the present invention offer several improvements over standard vessels currently used in industry. The improved cell culture devices remarkably enhance the volume of cells that are capable of being cultured in the volume enclosed by traditional cell culture vessels. The various benefits are attributable to the multi-layered arrangement of gas permeable membranes assembled into a unitary vessel. Successive layering of individual growth chambers and tracheal chambers inclusive of the gas permeable membranes makes oxygen and other gases from the external environment available to the internal contents of the apparatus. Specifically, gaseous exchange with the nutrient media is conducive to an even distribution of cell growth when gas permeable membranes are utilized on at least one potential growth surface. The cell growth apparatus is capable of fully utilizing its capacity by allowing cells access to optimal volumes of nutrient media and direct oxygenation via the tracheal spaces. Additional benefits are afforded to the cell culturing apparatus in which the exterior framework is rigidly constructed, conveniently offering easy handling, storage, and accessibility.

In one embodiment, the present invention has a footprint conforming to industry standard for microplates (5.030+/−0.010 inches by 3.365+/−0.010 inches). For this reason, the neck portion is preferably recessed within the overall rectangular footprint. The advantage of providing an apparatus with such a footprint is that automated equipment designed specifically for the manipulation of microplates may be utilized with this apparatus with very little customized modification. Similarly the height, or the distance between the outer most portion of the bottom tray and the outer portion of the top

plate, is approximately 0.685+/−0.010 inches. At any rate, the present invention is not intended to be limited in any way by the aforementioned preferred dimensions and in fact may be constructed to any dimension.

As exemplified, the apparatus may include any unitary structure, vessel, device or flask with the capacity to integrally incorporate substrates in successive orientation. The invention being thus described, it would be obvious that the same may be varied in many ways by one of ordinary skill in the art having had the benefit of the present disclosure. Such variations are not regarded as a departure from the spirit and scope of the invention, and such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims and their legal equivalents.

The invention claimed is:

1. A method of culturing cells in a cell growth apparatus, the method comprising:

(a) providing a cell growth apparatus comprising: a plurality of cell growth chambers, each having a gas permeable, liquid impermeable membrane, an opposing surface, and at least one side wall connected to at least one of the gas permeable, liquid impermeable membrane and the opposing surface; and at least one tracheal space in communication with at least one gas permeable, liquid impermeable membrane of at least one cell growth chamber; wherein the at least one tracheal space comprises peripheral supports on a peripheral edge of the tracheal space; wherein the supports on the peripheral edge of the tracheal space are spaced apart to create a plurality of gaps to allow gasses to flow from an external environment into the tracheal space through the plurality of gaps between peripheral supports;

(b) introducing cells and media into said plurality of cell culture chambers of said apparatus, and

(c) incubating said apparatus.

2. The method according to claim **1**, further comprising a step of rotating the apparatus to culture cells on an opposing surface of said gas permeable, liquid impermeable surface.

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FORM 19. Certificate of Compliance with Type-Volume Limitations **Form 19**
July 2020

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME LIMITATIONS

Case Number: 24-1065

Short Case Caption: Wilson v. Coring Incorporated

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Signature: /s/Devan V. Padmanabhan

Name: Devan V. Padmanabhan